Documentation of an Ozone Exceptional Event

Wasatch Front, Utah
July 8-9, 2008

Purpose of Report

- The Utah Division of Air Quality (UDAQ) is flagging ozone data for removal from regulatory consideration
- This is the follow-up documentation for the event that was initially flagged and described in AQS.

Regulatory Process

- Treatment of Data Influenced by Exceptional Events is covered in 40 CFR Parts 50 and 51.
- Guidance for the regulations can be found at 72 FR 55 March 22, 2007 13560-81.
- Federal Register November 21, 2008, Volume 73, #226, Pages 70597 to 70598

Event Description

- Regional smoke impact lasted several days.
- The Initial smoke in the Northwest, including Utah, is shown to have come from fires in California, Alaska and even Russia. The excedance that is treated in this documentation was influenced by the initial arrival of the smoke from the Northern California Lightning Series wildfire.
- Copies of Articles obtained from the U.S. Air Quality Smog Blog (http://alg.umbc.edu/usaq) are attached in Appendix A they describe the regional wildfire smoke impact.
- Upwind of the Wasatch Front exceptional event, Washoe County, Nevada also flagged PM2.5 data for a wildfire exceptional event that encompassed the following dates:
    - June 24-25, 2008
    - July 2-3, 2008
    - July 6-7, 2008
    - July 10-13, 2008

  The Nevada exceedance dates of July 6-7 are directly associated with the wildfire events presented in this documentation
- During the smoke impact the ozone standard was exceeded in the Wasatch Front for two days associated with the arrival in the Wasatch Front of additional smoke from the wildfire complex known as the Northern California Lightning Series.
    - The exceedance days along the Wasatch Front were:
        - July 8, 2008 and
        - July 9, 2008
    - Beginning July 8, hourly PM2.5 values collected in the network indicate an increase coinciding with the ozone increase and the arrival of the smoke plume.

Table 1. List of monitors affected **July 8, 2008**, and their values.

Monitor	ppm	ppm	AQS Mon. #	Lat.	Long.
Brigham City	0.080	0.079	49-003-0003	41.49289	-112.01775
Harrisville	0.081	0.080	49-057-1003	41.30266	-111.98641
Bountiful	0.085	0.084	49-011-0004	40.90290	-111.88443
Hawthorne	0.080	0.079	49-035-3006	40.73436	-111.87201
Beach	0.078	0.077	49-035-2004	40.73426	-112.21029
Cottonwood	0.086		49-035-0003	40.64405	-111.84976
Tooele	0.079		49-045-0003	40.53939	-112.29972
Highland	0.088		49-049-5008	40.42819	-111.80396
North Provo	0.089	0.088	49-049-0002	40.25336	-111.66328
Spanish Fork	0.091		49-049-5010	40.13830	-111.66020

Table 2. List of monitors affected **July 9, 2008**, and their values.

Monitor	ppm	ppm	AQS Mon. #	Lat.	Long.
Bountiful	0.078		49-011-0004	40.90290	-111.88443
Cottonwood	0.088	0.087	49-035-0003	40.64405	-111.84976
Hawthorne	0.076	0.075	49-035-3006	40.73436	-111.87201
North Provo	0.093	0.092	49-049-0002	40.25336	-111.66328
Highland	0.086	0.085	49-049-5008	40.42819	-111.80396
Spanish Fork	0.088	0.087	49-049-5010	40.13830	-111.66020
Harrisville	0.078	0.077	49-057-1003	41.30266	-111.98641

- The following documentation will address each of the required elements of the exceptional events regulations regarding these data points.

- A weight of evidence will be provided that concludes that this data should be removed from regulatory consideration.

Description of Wildfires

- The following excerpts are from the references footnoted below.

  The California wildfires of Summer 2008 (collectively dubbed the Northern California Lightning Series by CAL FIRE) were wildfires during Summer 2008, with over 2,780 individual fires (at the series' height), affecting large portions of forests and chaparral in California. The majority of the fires were started by lightning from dry thunderstorms on June 20[1], although some earlier fires were started on June 6. International aid from Greece, Chile, Argentina, Brazil, Australia, Canada, Mexico and New Zealand was present to help fight the fires.[2]

- Smoke from these fires, from Alaska and Russia began to arrive along the Wasatch Front as early as July 3, 2008 and lasted through July 14, 2008.

- During this period of time, ozone concentrations throughout the Utah monitoring network remained below the 0.075 standard with the exception of July 8th and July 9th.

- On these dates the arrival of an increased concentration of smoke from the wildfire complex known as the Northern California Lightning Series contributed to the formation of ozone resulting in elevated monitored values throughout the network.

1 Bulwa, Demian (2008-06-23). "Firefighters battling hundreds of blazes". San Francisco Chronicle. Retrieved on 2008-07-07.

[2] RIECHMANN, DEB (2008-07-17). "hBush surveys record-breaking California wildfires". Yahoo. Retrieved on 2008-07-17.)

Figure 1. NASA/USDA- Forest Service, Remote Sensing Applications Center, MODIS Rapid Response System, http://rapidfire.sci.gsfc.nasa.gov/realtime/?calendar

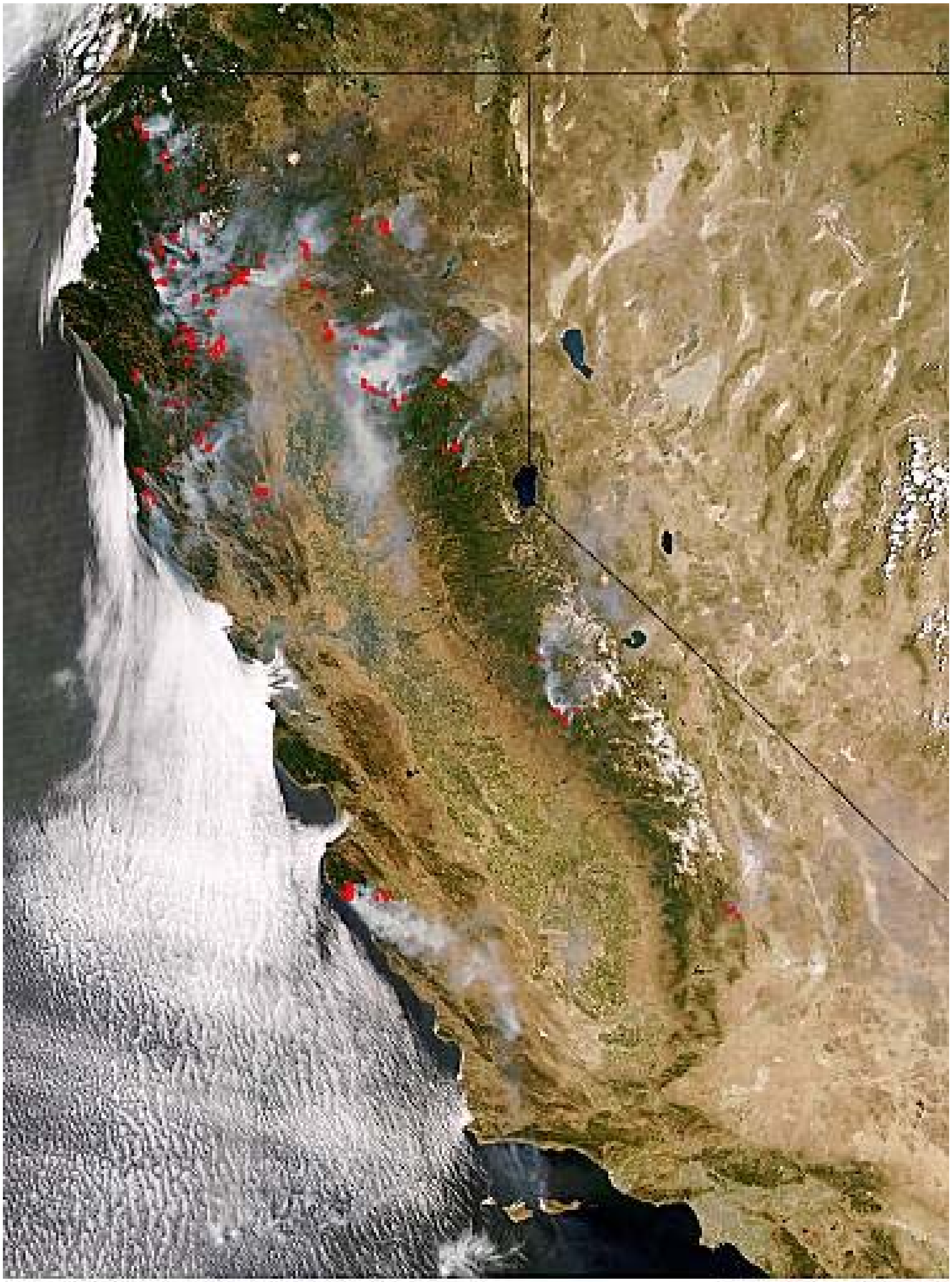

Figure 2. Satellite image showing the numerous wildfires burning in California, June 23, 2008. Reuters photo by NASA http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/06/24/BAS011DN5B.DTL&hw=wildfire&sn=050&sc=203

Wildfire Affected Air Quality

- The following chart is a forecast from the Naval Research Laboratory (NRL) for July 8, 2008. This demonstrates that by July 8 the smoke plume from the Northern California wildfire was expected to enter the region.

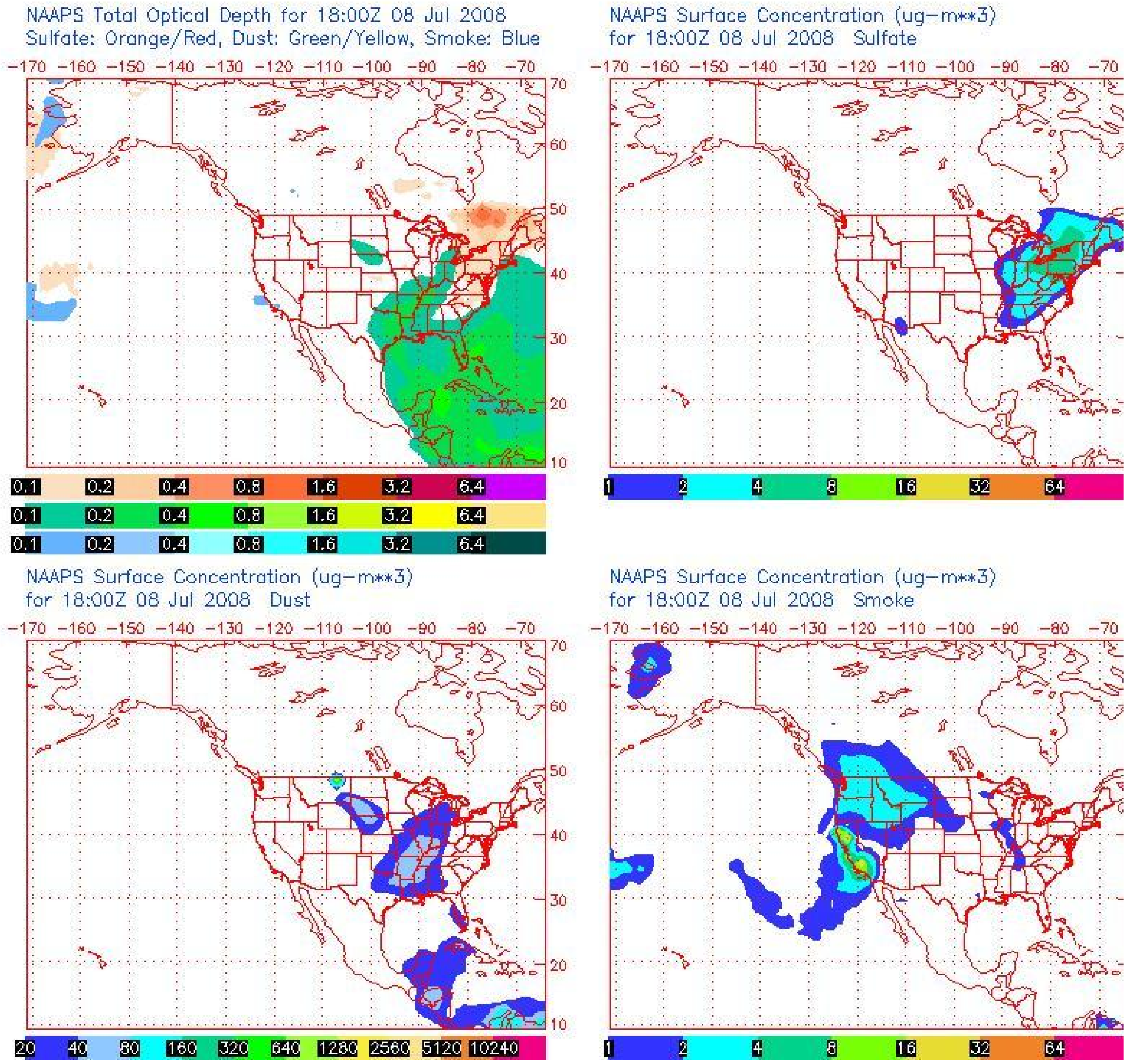

Figure 3. Screen Save from Naval Research Laboratory (NRL), Monterey Marine Meteorology Div., Satellite Meteorology - Monterey Aerosol, for July 8, 2008.
http://www.nrlmry.navy.mil/aerosol/#satelliteanalyses

- Figure 4 compares the speciated particulate matter, less than 2.5 microns in diameter (PM2.5), from three days at the Hawthorne speciation monitor in Salt Lake County, UT . Speciation monitoring provides information on the chemical composition of the PM2.5 collected.

- Data from a representative summer day previous to the event, data from a day during the event and data from a day following the event that is in the time period the regional smoke was present are represented.
- Speciation data is useful as one can report total carbon.
- The values measured during the event have a notably higher total carbon level represented as a percentage of the filter mass.

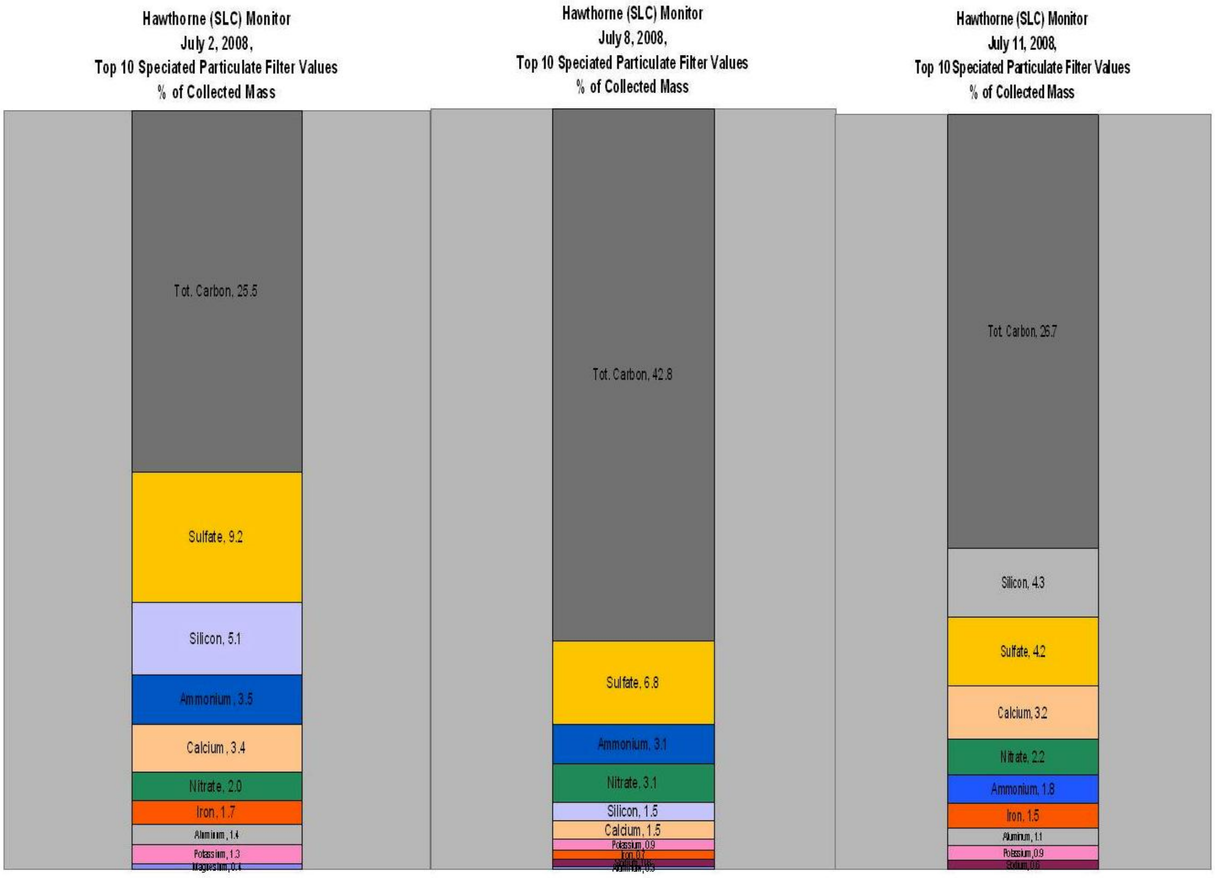

Figure 4. Charts showing July 2, 8, & 11, 2008 data values collected at the Hawthorne speciation monitor in Salt Lake County Utah, generated by Utah Division of Air Quality staff.

- Figure 5 shows the progress of the ozone Air Quality Index values as they influenced the western region of the United States as the smoke from the Northern California Lightning Series wildfire complex was distributed toward the east. The images were generated using the "Air Now" cross agency website http://airnow.gov/.

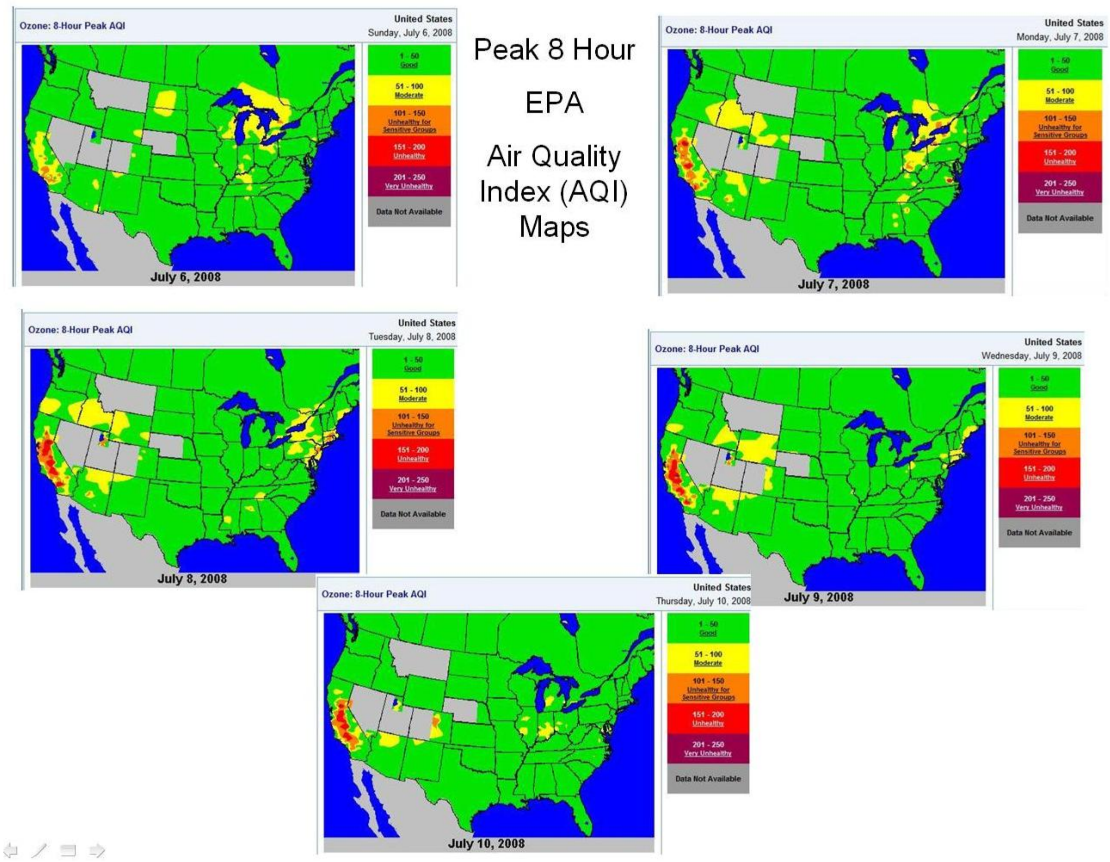

Figure 5. Screen save from "Air Now", cross agency website http://airnow.gov/, before, during, and after the event.

- Figure 6 is generated from the National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data and Information Services (NESDIS), website http://map.ngdc.noaa.gov/website/firedetects/viewer.htm and shows the cumulative impact of the smoke plumes from the Northern California Lightning Series wildfire

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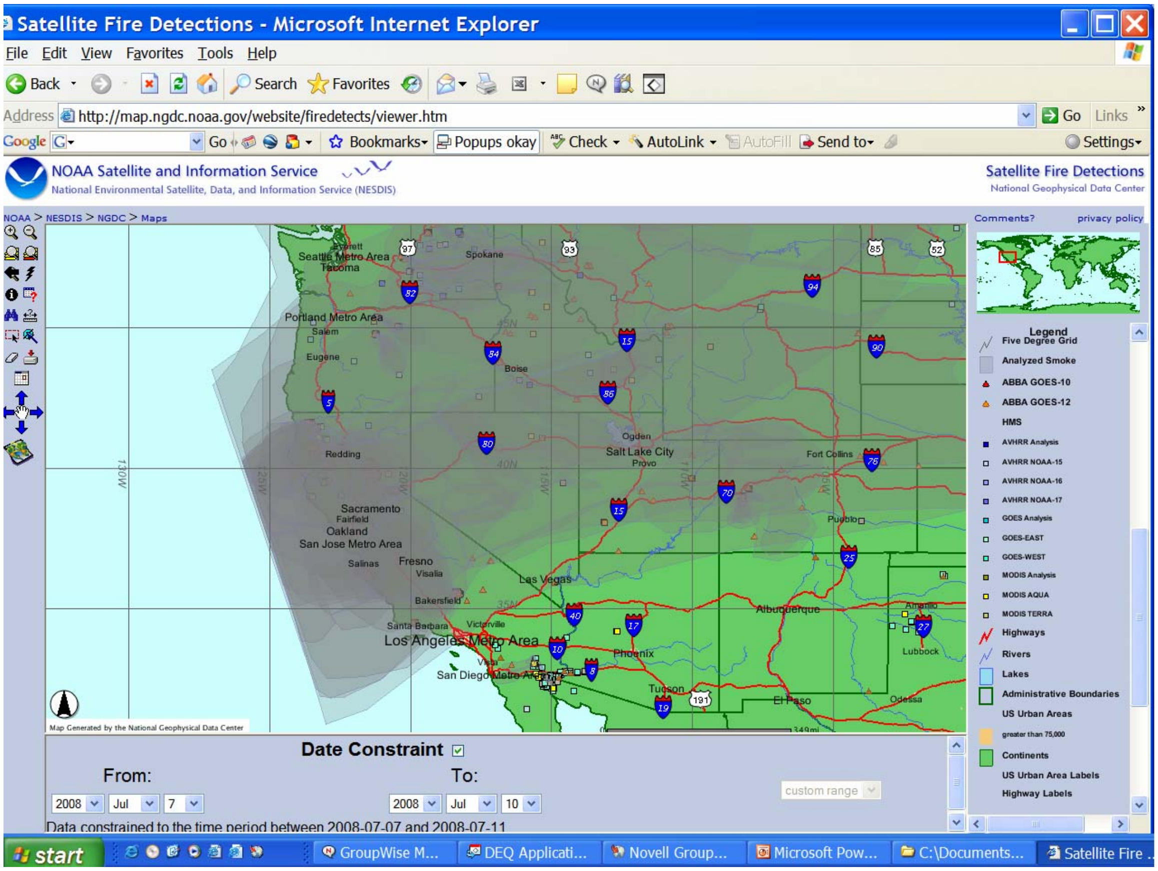

Figure 6. Screen save from National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data and Information Services (NESDIS), website http://map.ngdc.noaa.gov/website/firedetects/viewer.htm.

- In support of the demonstration that ozone formation was related to the arrival of the smoke from the Northern California Lightning Series wildfire the following article is attached:
  - **"Influence of Fires on O3 Concentrations in the Western U.S." Environmental Science and Technology Journal (available at http://pubs.acs.org/page/esthag/about.html)**
    - DAN JAFFE, DULI CHAND, WILL HAFNER, ANTHONY WESTERLING, AND DOMINICK SPRACKLEN
    - *University of Washington Bothell, 18115 Campus Way NE,*
    - *Bothell, Washington 98011, University of California, Merced,*
    - *and University of Leeds, England UK*
  - Brief statement of the articles content: This article presents and supports the hypothetical case that variation in interannual ozone production in the western U.S. is influenced by the contributions of NO_x and hydrocarbons by wildfires. (The entire article can be read in Attachment A)

Wasatch Front Ozone Monitor Sites that Exceeded the Standard during the July 8-9, 2008 Wildfire Smoke Event

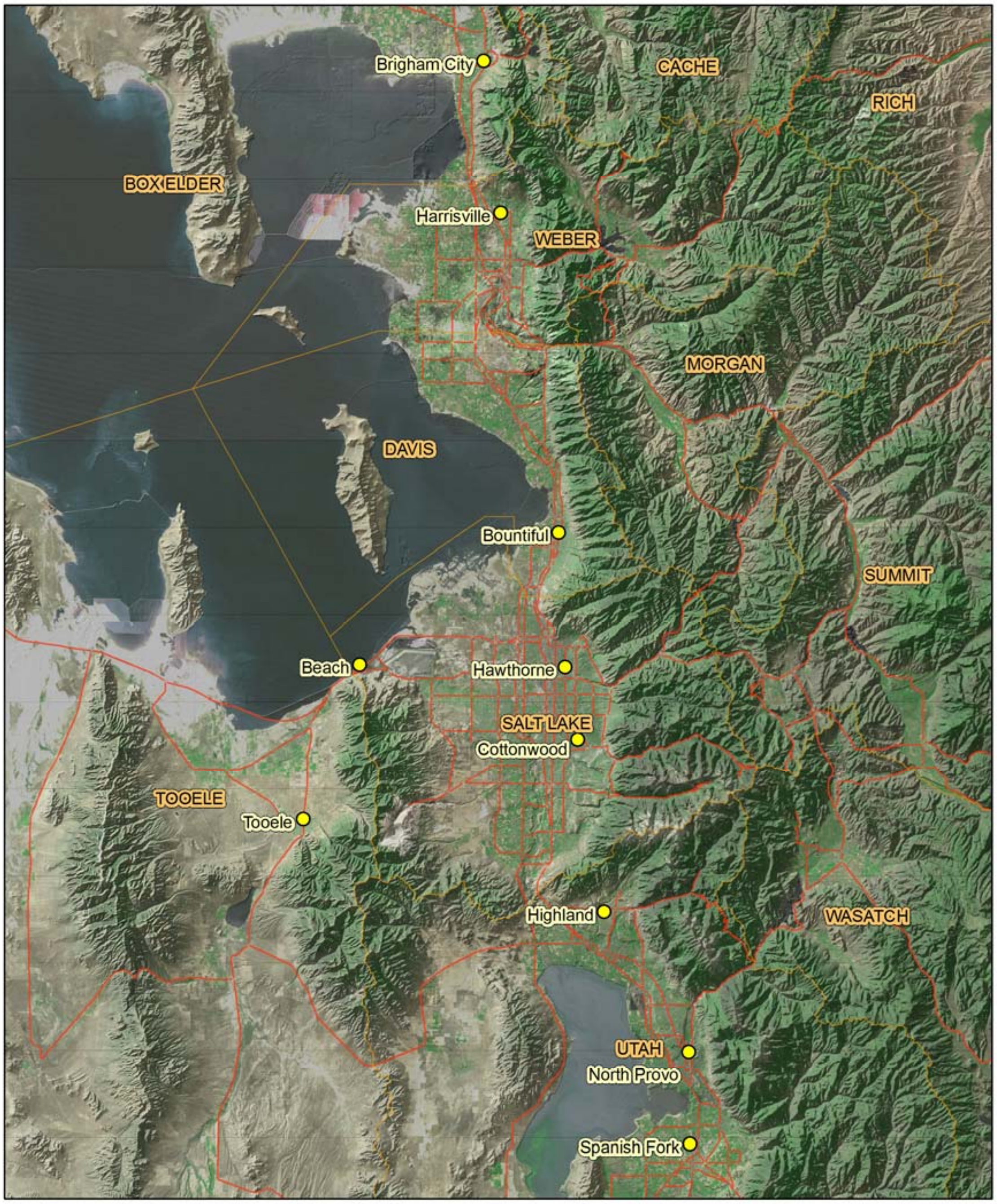

Figure 7. Map of the region impacted by the exceptional event generated from resources within the Utah GIS system including a Landsat30 image. (The locations of the effected monitors are shown by yellow dots, roads are shown in Orange, and county lines in light orange.)

- Figures 8 to 17 contain analysis of the direction from which the air mass at each monitor originated.

- The HYSPLIT model acquired from the following NOAA website was used to generate the maps below:

    - National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data and Information Services (NESDIS), http://www.ready.noaa.gov/ready/hysplit4.html

- The trajectories on the maps represent the modeled movement of the air mass that arrived at the monitor (indicated by the star) on the date and at the universal time indicated (this would be 12:00 MDT).

- Each color line corresponds to the elevation in meters of the air mass above the monitor. A lower elevation than 100 meters was not used in order to minimize the influence the highly complex terrain involved.

- The chart below the model map indicates the variation in elevation of the air mass going back in time.

- Longer trajectories were not used as the model is rather course and accuracy is greatly reduced over distances.

- The models do, however, indicate that the air mass arriving at Wasatch Front was coming from the northwest where the regional smoke was concentrated.

Brigham City

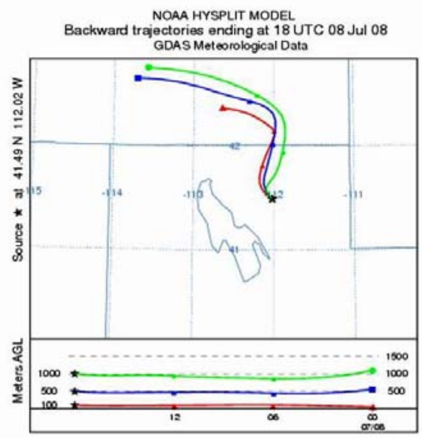

Figure 8. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Bountiful

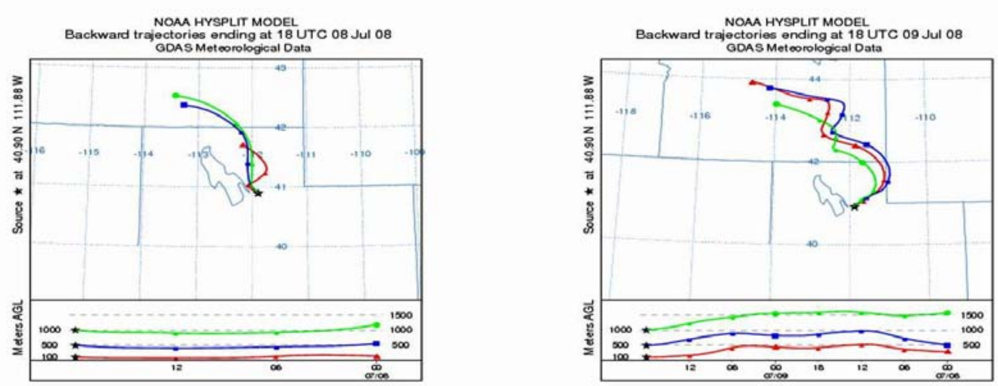

Figure 9. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Harrisville

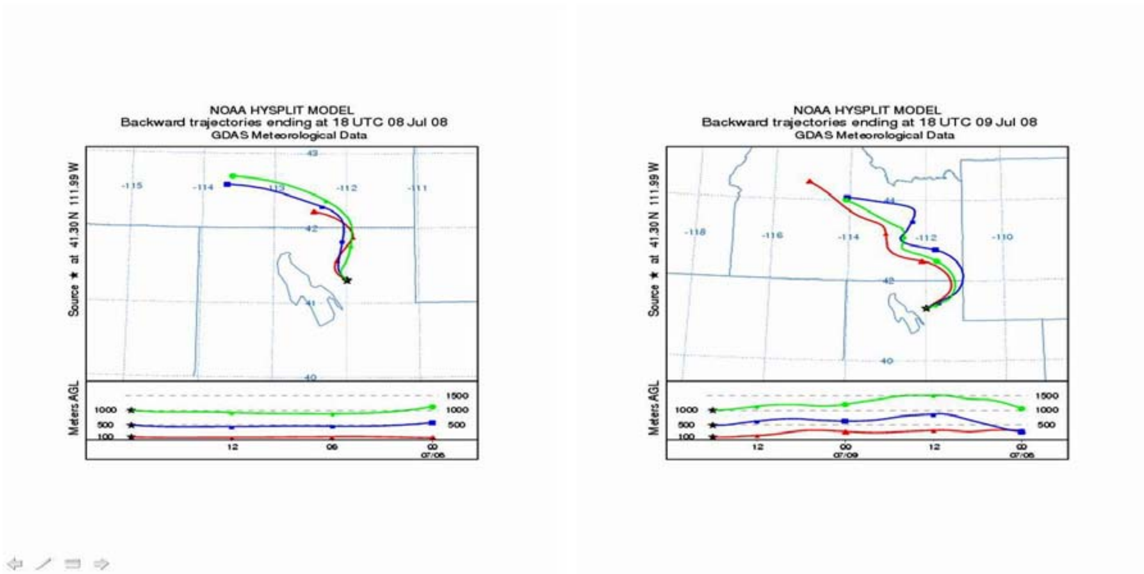

Figure 10. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Hawthorne

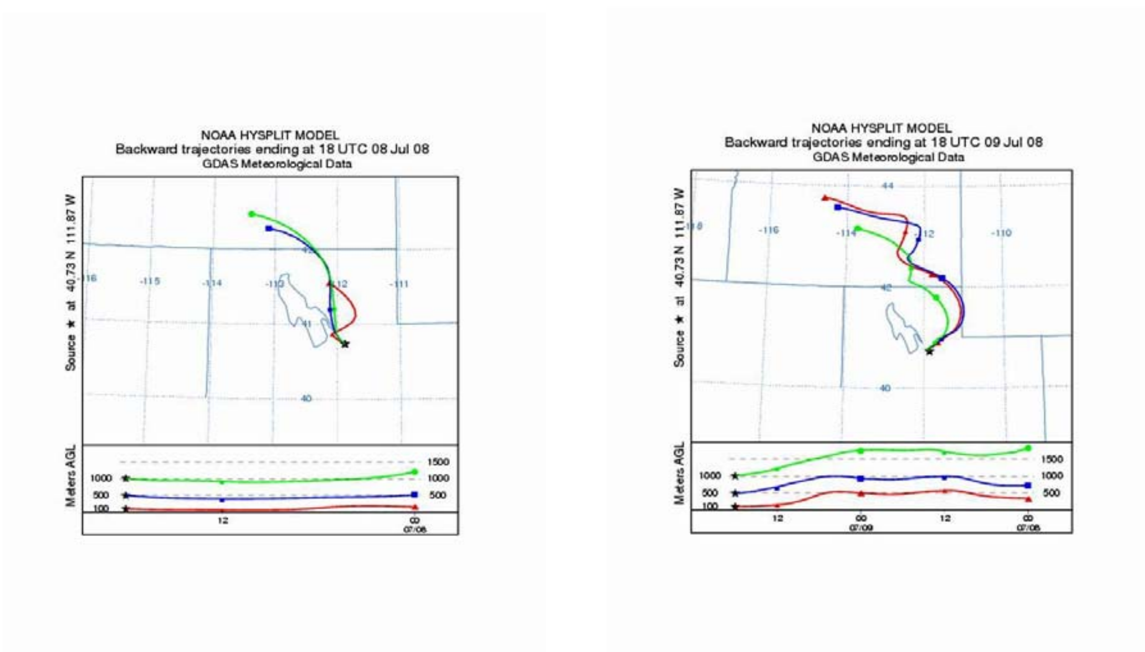

Figure 11. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Beach

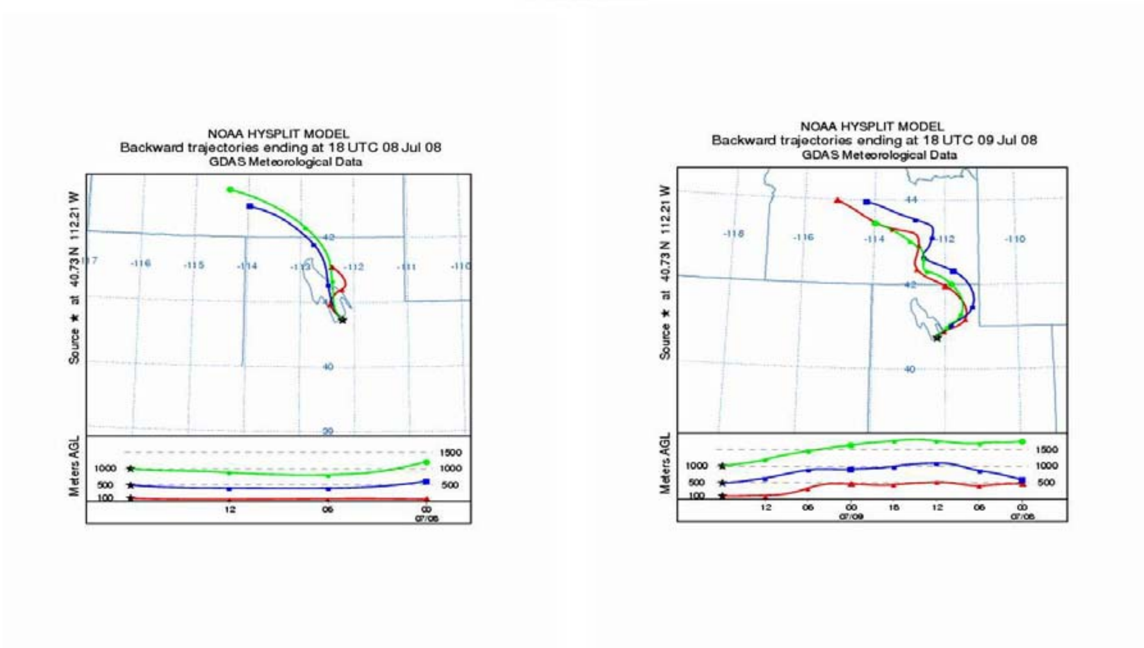

Figure 12. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Cottonwood

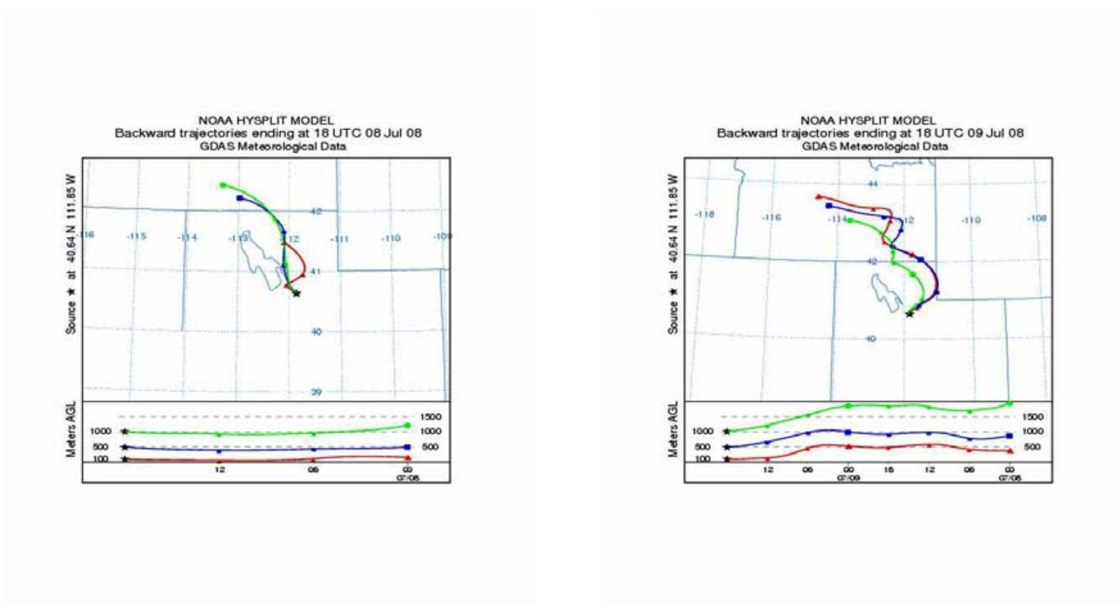

Figure 13. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Tooele

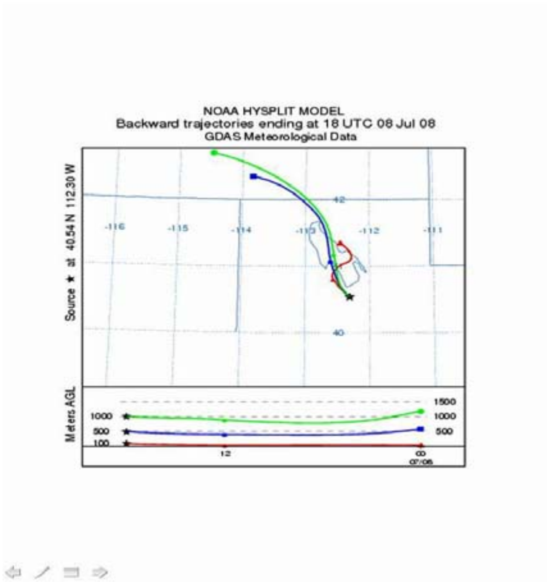

Figure 14. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Highland

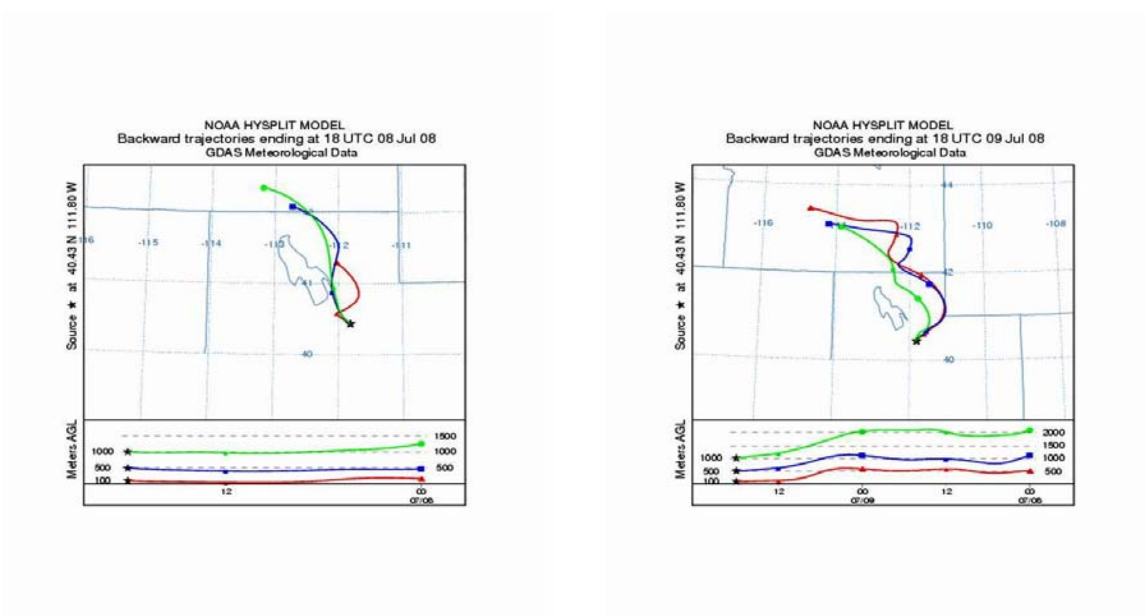

Figure 15. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

North Provo

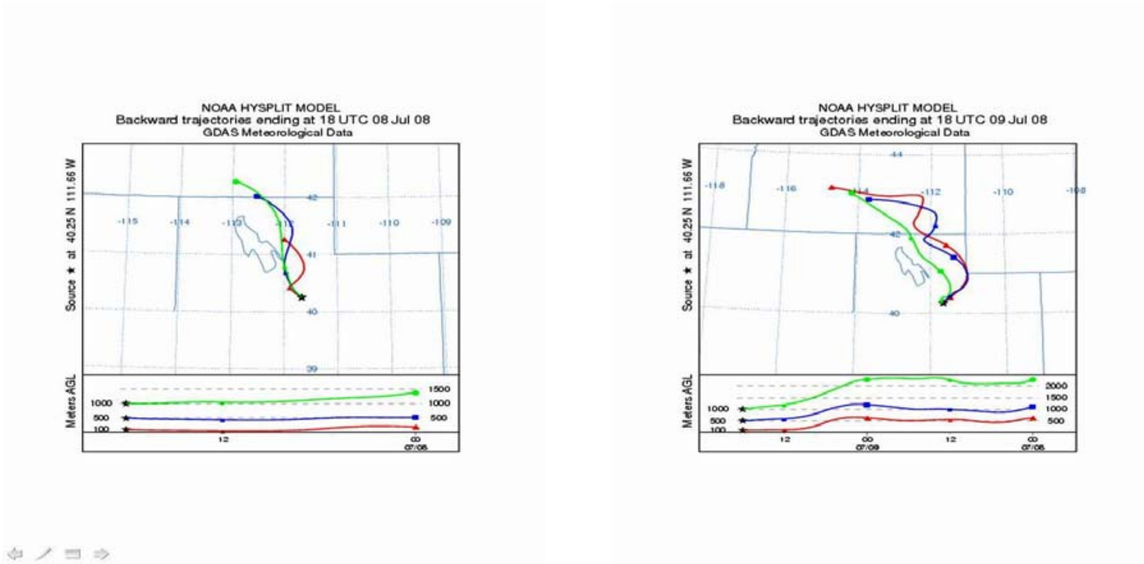

Figure 16. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

Spanish Fork

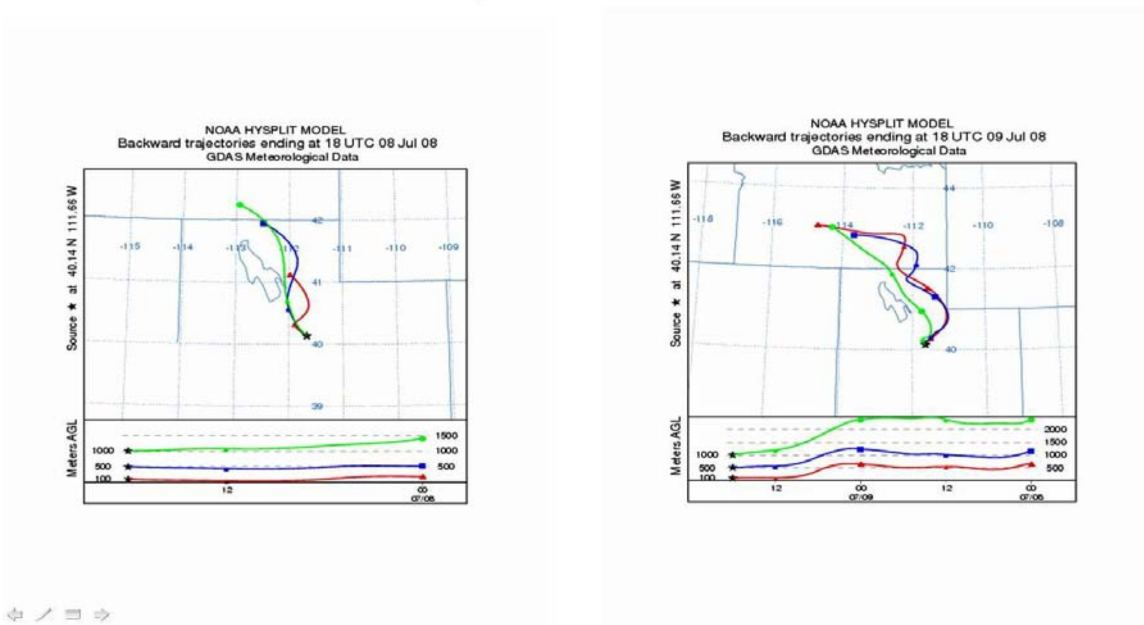

Figure 17. National Oceanic and Atmospheric Administration (NOAA), HYSPLIT Model Program, http://map.ngdc.noaa.gov/website/firedetects/viewer.htm

- Figures 18 to 21 present world maps of Total Ozone Mapping Spectrometer (TOMS) aerosol index. The colors on the maps are a measure of how much the wavelength dependence of backscattered UV radiation from an atmosphere containing aerosols differs from that of a pure molecular atmosphere.

- The influence of the smoke from the Northern California Lightning Series wildfire complex can clearly be seen in the sequence of maps.

- The arrival of this smoke coincides with the rise in ozone on the Wasatch Front monitoring network.

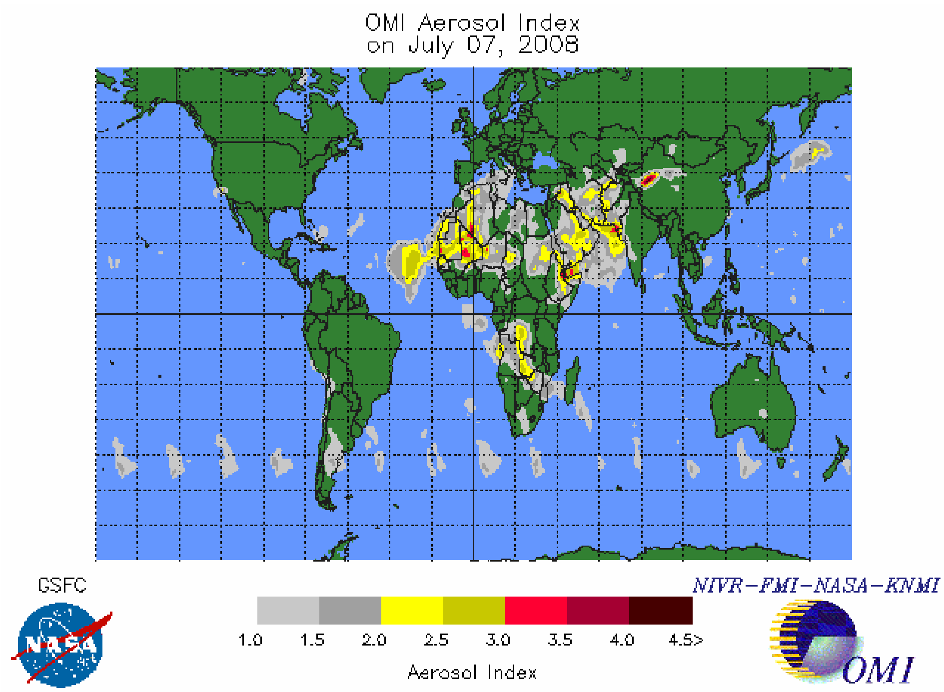

Figure 18. Screen Save from Total Ozone Mapping Spectrometer (TOMS), National Aeronautics and Space Administration (NASA)/Governmenatl Space Flight Ctr. (GSFC), Aerosol Index Data Procuct, http://toms.gsfc.nasa.gov/aerosols/aerosols.html

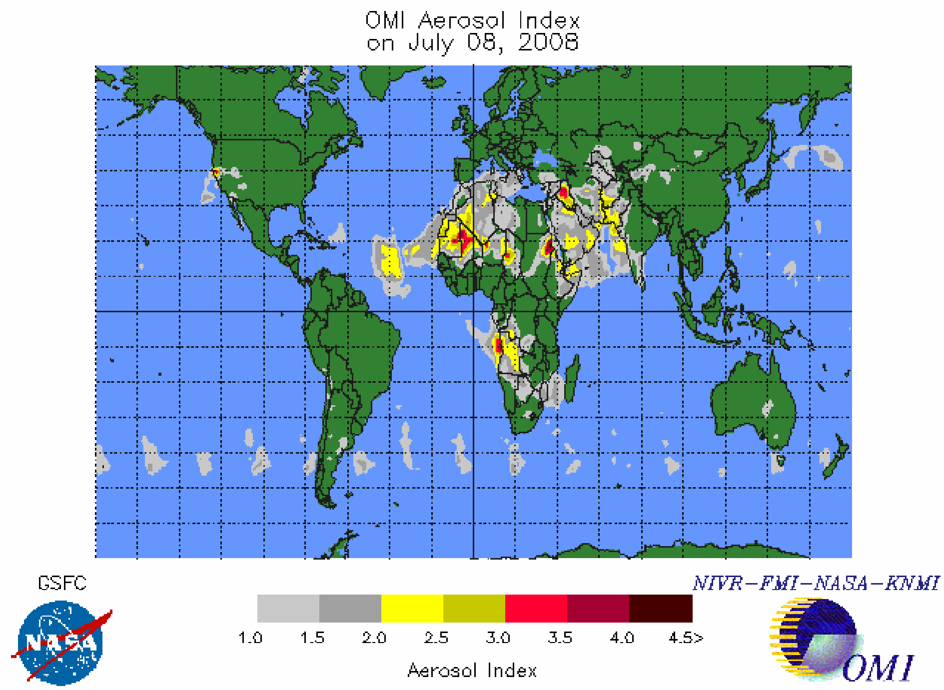

Figure 19. Screen Save from Total Ozone Mapping Spectrometer (TOMS), National Aeronautics and Space Administration (NASA)/Governmenatl Space Flight Ctr. (GSFC), Aerosol Index Data Procuct, http://toms.gsfc.nasa.gov/aerosols/aerosols.html

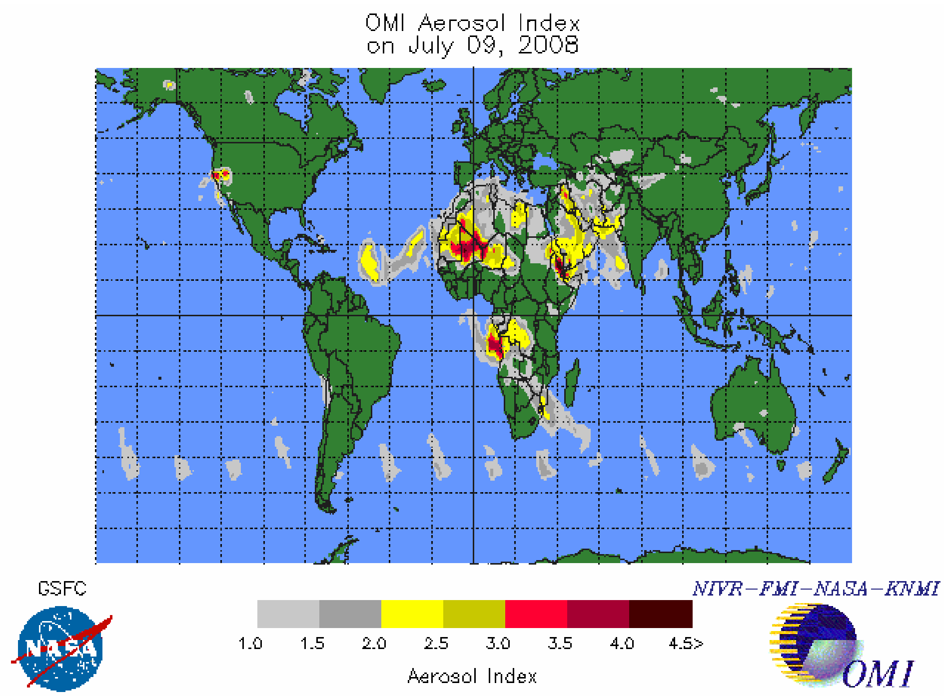

Figure 20. Screen Save from Total Ozone Mapping Spectrometer (TOMS), National Aeronautics and Space Administration (NASA)/Governmenatl Space Flight Ctr. (GSFC), Aerosol Index Data Procuct, http://toms.gsfc.nasa.gov/aerosols/aerosols.html

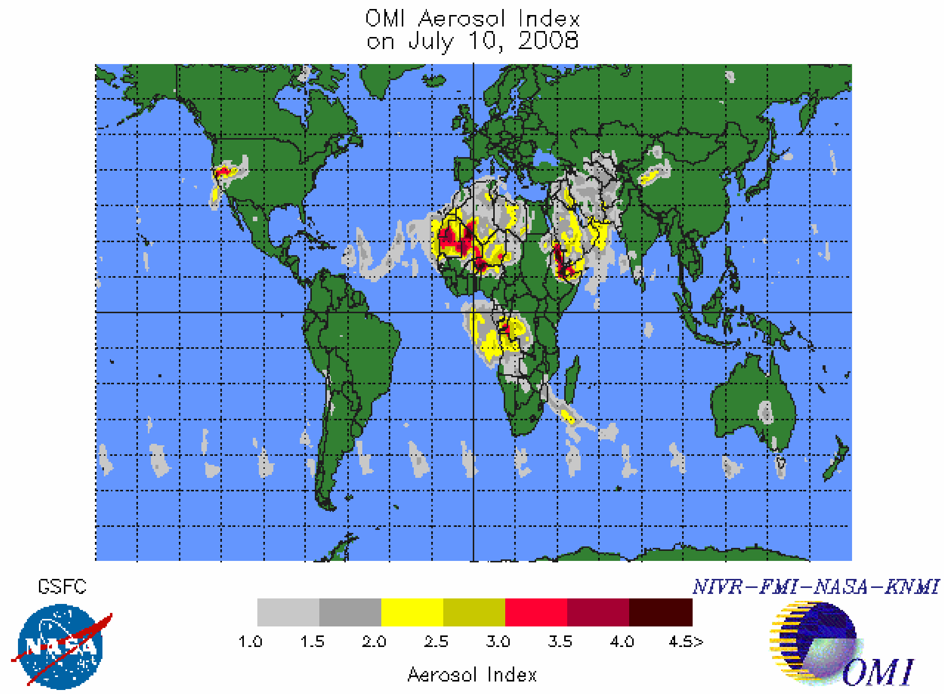

Figure 21. Screen Save from Total Ozone Mapping Spectrometer (TOMS), National Aeronautics and Space Administration (NASA)/Governmenatl Space Flight Ctr. (GSFC), Aerosol Index Data Procuct, http://toms.gsfc.nasa.gov/aerosols/aerosols.html

- During this event the temperatures recorded throughout the network remained in the low 90's and there were no other contributing meteorological causes that would produce increased ozone above normal concentrations to the extent observed.

- Figure 22 is from the Sugarhouse (Salt Lake City) site showing a representative location that presents several meterological parameters in the Wasatch Front from July 6 to July 10, 2008.

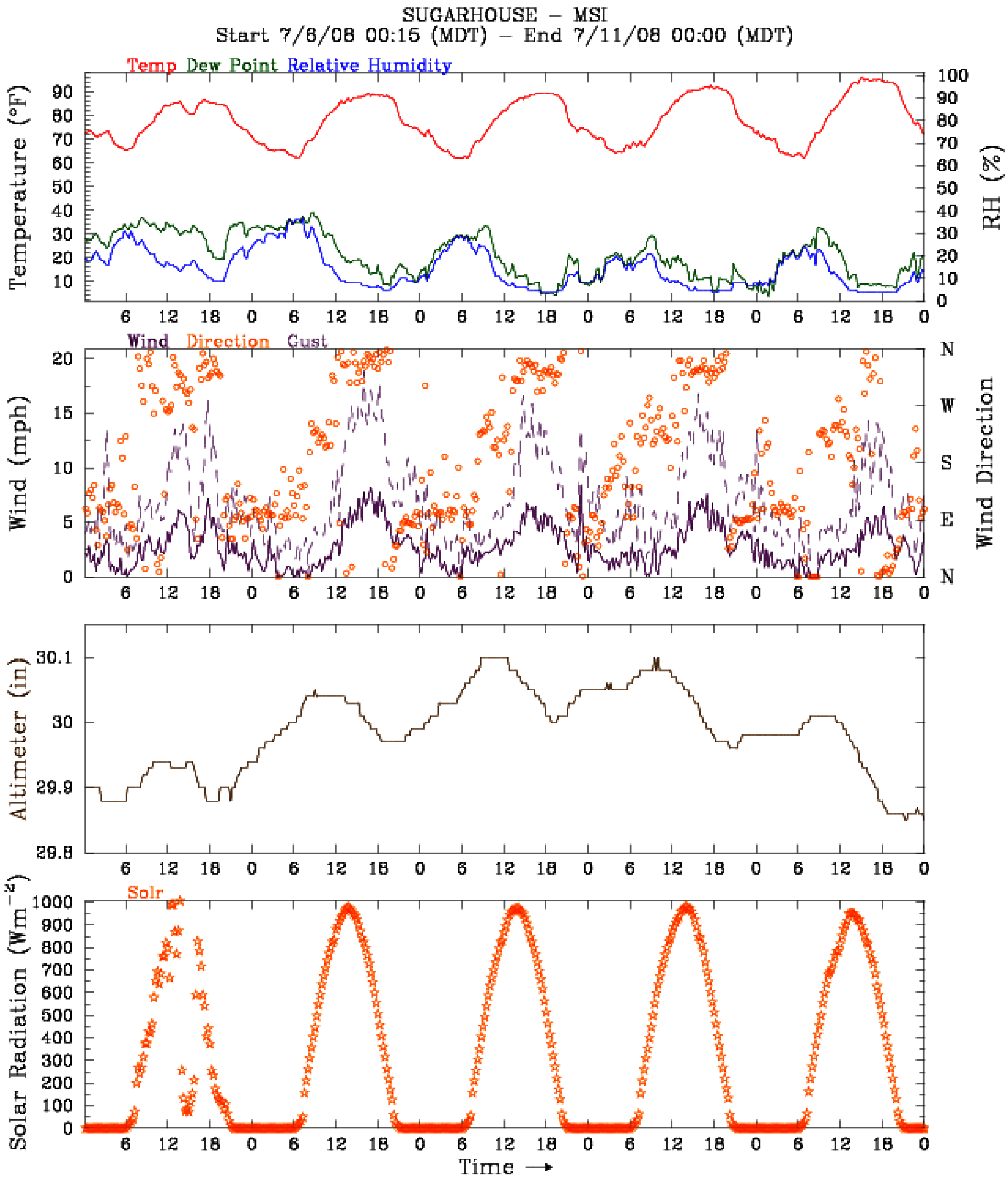

Figure 22. Weather data from July 6 - 10, 2008. University of Utah Metorology Dept., MESO West - Archived weather summary, http://www.met.utah.edu/cgi-bin/droman/raws_ca_monitor.cgi?state=UT&rawsflag=290

- This ozone event was influenced by wildfire smoke.
- DAQ has no control over wildfire events outside of the smoke management controlled burn program.
- Articles are attached in Attachment B from "U.S. Air Quality Smog Blog" (http://alg.umbc.edu/usaq). giving daily descriptions and images of the national smoke situation.

- Wildfire smoke was visible in the Salt Lake Valley on July 8 and 9, 2008. The comparisons below that demonstrate the marked visible variation from the days of the wildfire smoke to a normal summer day:

Average summer day June 9, 2008

Figure 23. Average summer day June 9, 2008 Photo from Meteorological Solutions Inc., Salt Lake City based Consulting Co. - Archived Valley Photos (MSI), http://www.metsolution.com/index.html

1st Exceptional Event Day July 8, 2008

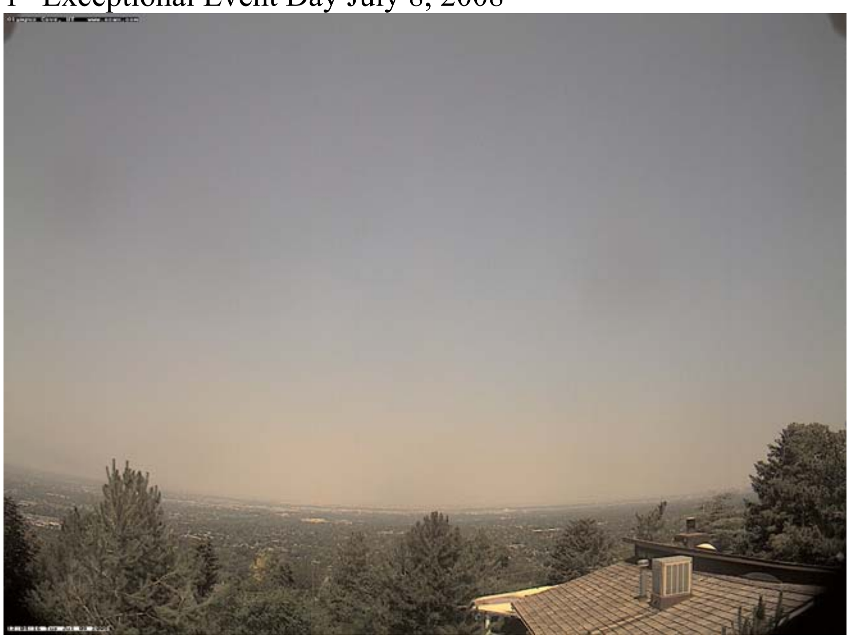

Figure 24. Valley obscured with regional smoke plume July 8, 2008 Photo from Meteorological Solutions Inc., Salt Lake City based Consulting Co. - Archived Valley Photos (MSI), http://www.metsolution.com/index.html

2nd Exceptional Event Day July 9, 2008

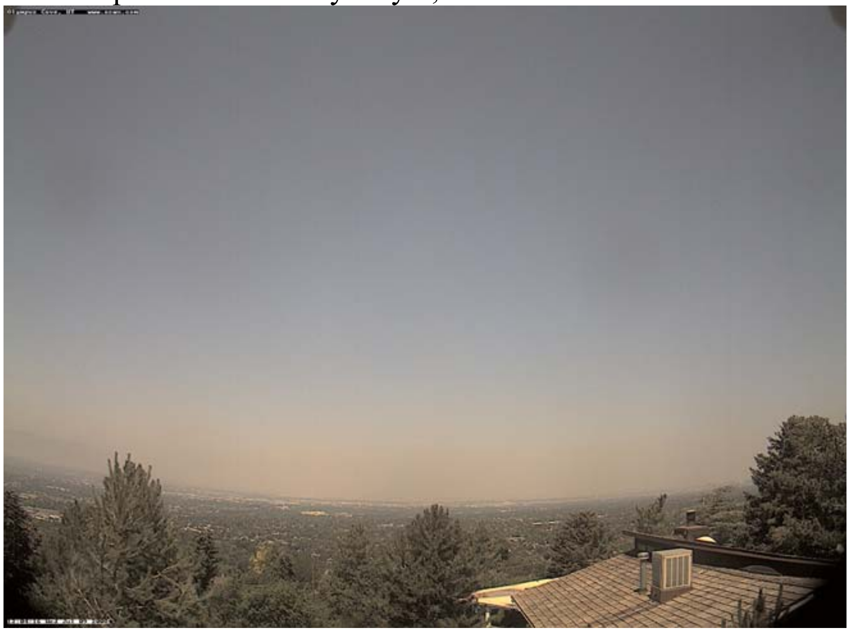

Figure 25. Valley obscured with regional smoke plume July 9, 2008 Photo from Meteorological Solutions Inc., Salt Lake City based Consulting Co. - Archived Valley Photos (MSI), http://www.metsolution.com/index.html

- Figure 26 and Figure 27 show that the PM2.5 and ozone monitors in the Wasatch Front network were simultaneously effected by the arrival of the smoke from the Northern California Lightning Series fires as seen by the rise in PM2.5 hourly and ozone 8 hour average values on July 8 and 9, 2008.

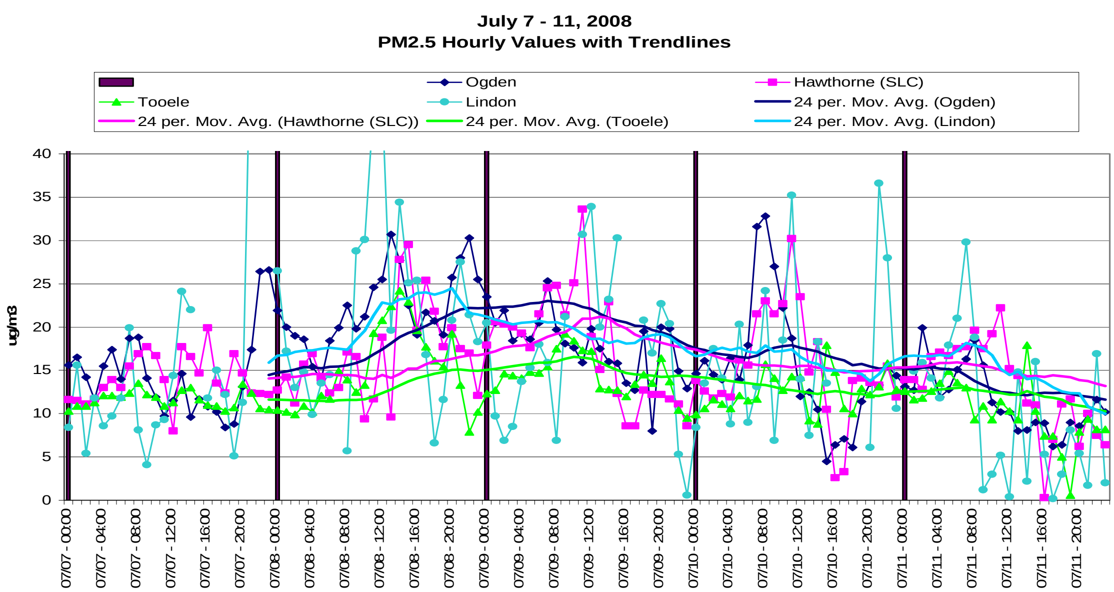

Figure 26. Graphical presentation of PM2.5 hourly levels associated with the exceptional event. Graph generated from resources within the Utah Division of Air Quality data system. The smooth lines are 24-hour average trend lines

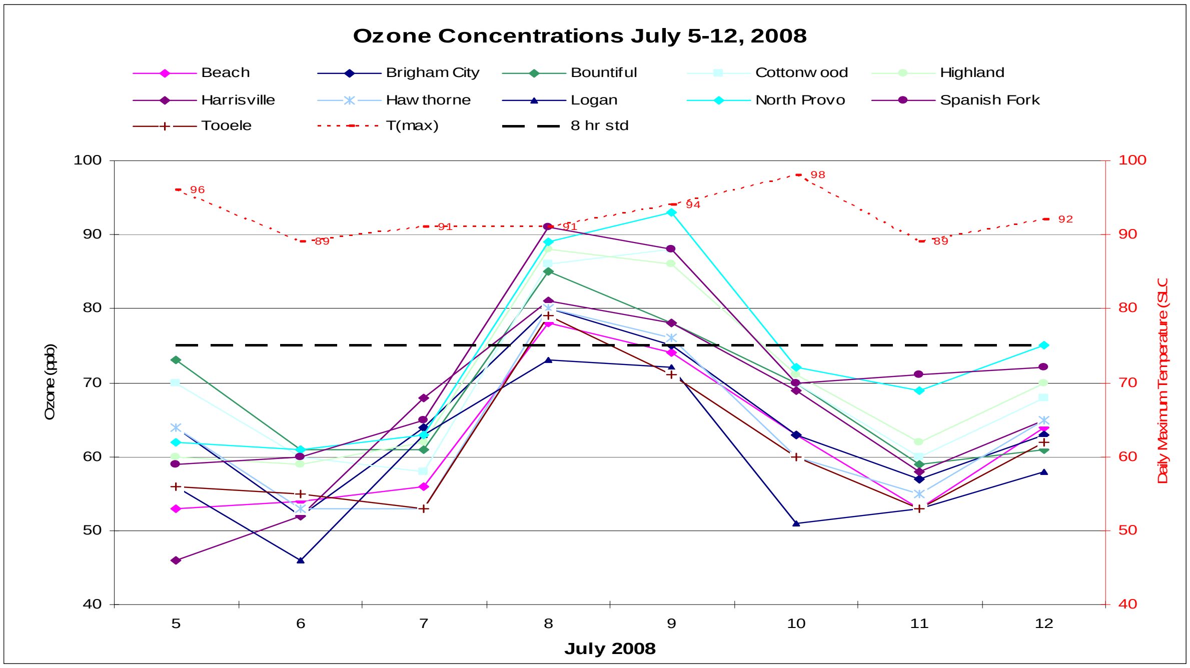

Figure 27. Graphical presentation of ozone max. 8 hour average levels associated with the exceptional event. Graph generated from resources within the Utah Division of Air Quality data system

<u>Concentration in Excess of Normal Fluctuations/ and No Exceedance but for the Event.</u>

The following analysis will demonstrate that the concentration is in excess of <u>normal historical fluctuations</u>, and that there would have been no exceedance or violation <u>but for the event</u>. The analysis was completed using Minitab© 15 Statistical Software. The data used for this analysis was compiled form the EPA AIRS AQS database and Utah's own monitoring network.

Analyses of these events are as fallows.

Location:	Pages:
Brigham City	24-29
Harrisville	30-35
Bountiful	36-41
Hawthorne	42-47
Beach	48-53
Cottonwood	54-59
Tooele	60-65
Highland	66-71
North Provo	72-77
Spanish Fork	78-83

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 12-years of historical data from the Brigham City monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 2001 through 2008 were included.

- Data from the Brigham City monitor since 2001 shows that ozone concentration of these dates were above the 95 percentile (%ilt).
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 97.7 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.055
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.234
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.068
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.084
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.104

- Figure 28 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

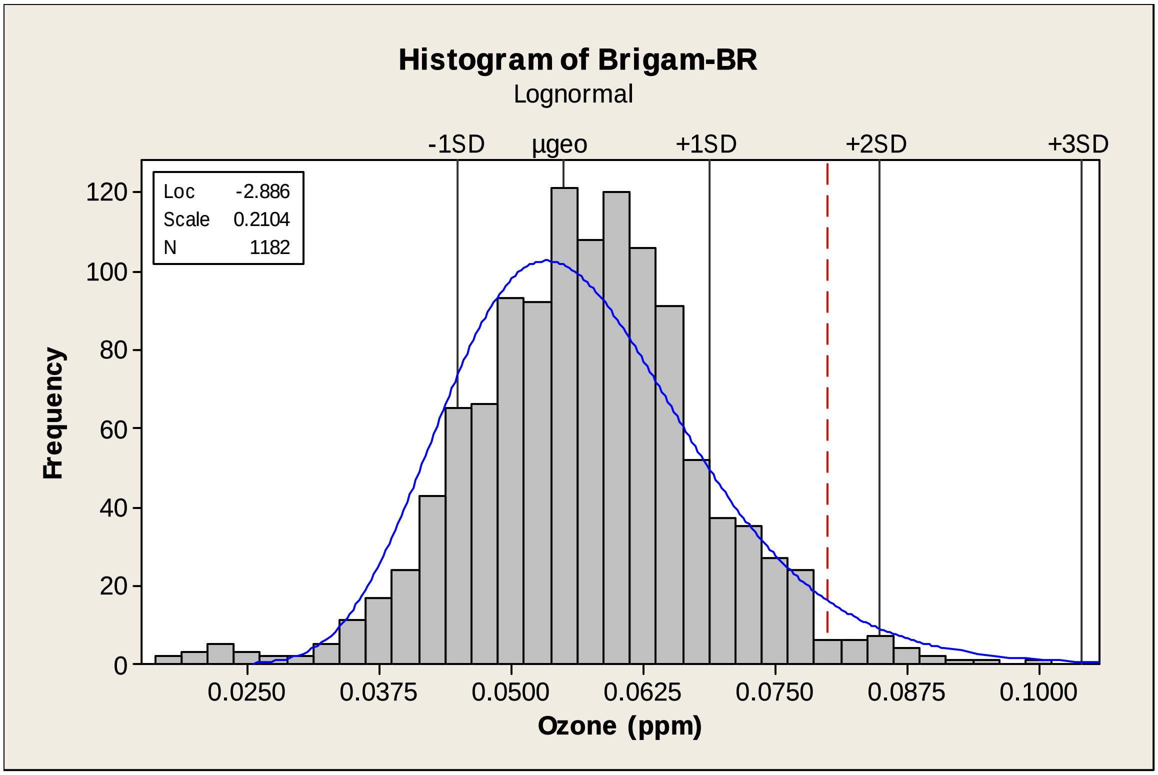

Figure 28. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 2001-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.080 ppm.
- The difference between the measured concentration and the Geometric Mean is 0.025 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Brigham City monitoring site would then be 0.068 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.012 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Syracuse, 49-011-6002, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables where calculated from the data.

Table 3. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 4 is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.

  – Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 4. Best Subset Regression Analysis for the Brigham City Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Change	Average Windspeed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	38.8	38.8	128.7	0.0087530	X															
1	38.8	38.7	130.0	0.0087586			X													
2	44.9	44.8	22.0	0.0083091	X											X				
2	44.0	43.9	39.1	0.0083811		X										X				
3	45.6	45.4	12.3	0.0082634	X										X	X				
3	45.5	45.3	13.9	0.0082704	X									X		X				
4	45.9	45.7	8.7	0.0082441	X						X				X	X				
4	45.8	45.6	9.9	0.0082492	X								X		X	X				
5	46.2	45.9	6.5	0.0082302	X						X		X		X	X				
5	46.1	45.9	6.8	0.0082315	X			X			X				X	X				
6	46.4	46.1	3.2	0.0082120	X						X	X	X		X	X				
6	46.4	46.1	4.2	0.0082160	X			X			X		X		X	X				
7	46.6	46.2	2.9	0.0082063	X			X			X	X	X		X	X				
7	46.6	46.2	3.4	0.0082083	X	X					X	X	X		X	X				
8	46.7	46.2	3.5	0.0082042	X		X	X			X	X	X		X	X				
8	46.6	46.2	3.9	0.0082059	X			X			X	X	X		X	X			X	
9	46.7	46.2	4.5	0.0082044	X		X	X			X	X	X		X	X			X	
9	46.7	46.2	4.6	0.0082047	X		X	X			X	X	X		X	X		X		
10	46.7	46.2	6.1	0.0082071	X		X	X		X	X	X	X		X	X				X
10	46.7	46.2	6.1	0.0082072	X		X	X		X	X	X	X		X	X			X	
11	46.8	46.1	7.8	0.0082101	X	X	X	X		X	X	X	X		X	X				X
11	46.8	46.1	7.8	0.0082102	X	X	X	X		X	X	X	X		X	X			X	
12	46.8	46.1	9.5	0.0082132	X	X	X	X		X	X	X	X		X	X	X			X
12	46.8	46.1	9.6	0.0082133	X	X	X	X		X	X	X	X		X	X	X		X	
13	46.8	46.0	11.4	0.0082169	X	X	X	X		X	X	X	X		X	X	X	X		X
13	46.8	46.0	11.5	0.0082171	X	X	X	X		X	X	X	X		X	X		X	X	X
14	46.8	46.0	13.2	0.0082202	X	X	X	X		X	X	X	X		X	X	X	X	X	X
14	46.8	46.0	13.2	0.0082204	X	X	X	X	X		X	X	X		X	X	X	X	X	X
15	46.8	46.0	15.1	0.0082241	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
15	46.8	46.0	15.1	0.0082242	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
16	46.8	45.9	17.0	0.0082281	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created:
  Predicted = 0.00627 + (0.00139 * Avg Temp) + (0.000312 * Max Temp) – (0.000581 * Avg Aft. Temp) +(0.000255 * Temp Change) - (0.000172 * Max RH) + (0.000354 * RH Change) - (0.000018 * Average Windspeed) + (0.000016 * Max Wind Speed) + (0.000092 * Average Wind St Dev Hz) + (0.000054 * Average Solar) + (0.000028 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 1182 observations from, 2001-2008, only 9964 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

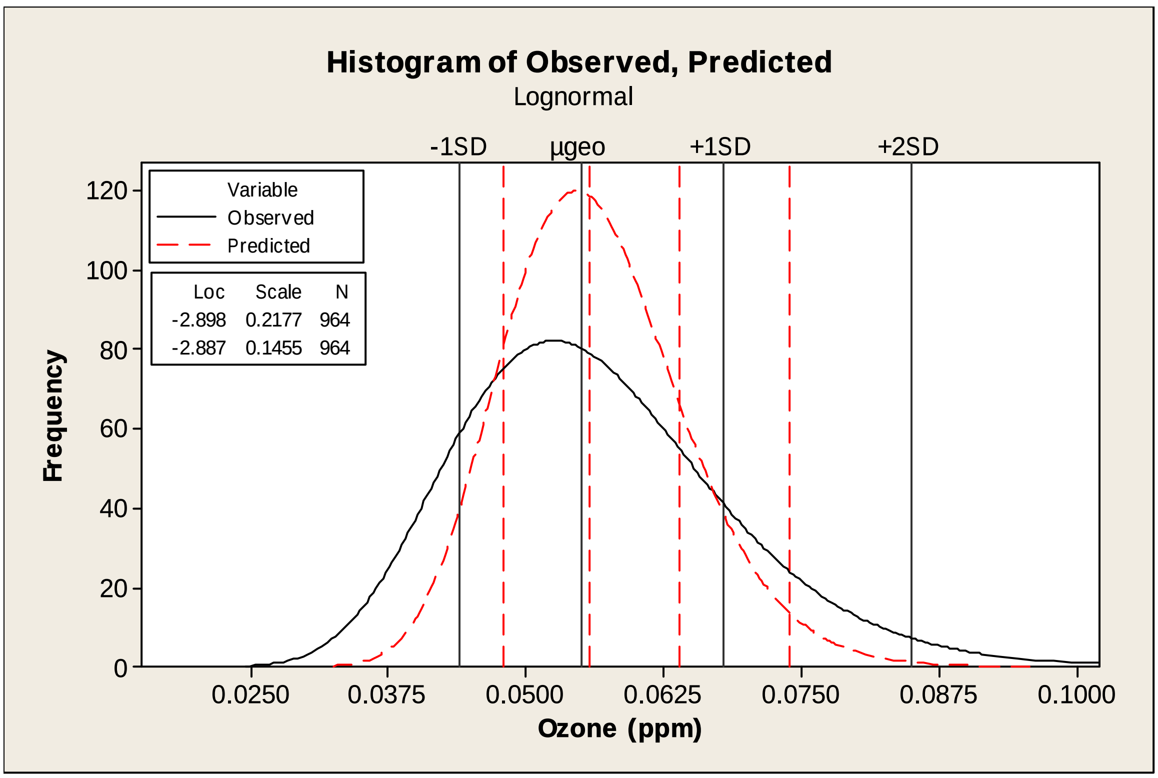

Figure 29. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 29 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

- **Table 5**. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	964	0	0.056333	0.000360	0.011187	0.016750	0.049375
Predicted	964	0	0.056308	0.000247	0.007656	0.030374	0.051180
Diff	964	0	-0.000025	0.000263	0.008163	-0.032810	-0.004684

Variable	Median	Q3	Maximum
Observed	0.056330	0.063000	0.099000
Predicted	0.057785	0.062226	0.071705
Diff	-0.000009	0.005242	0.030470

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.016 ppm if the observed.
  - During the event Ozone was under predicted by 0.021 ppm on July 8, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

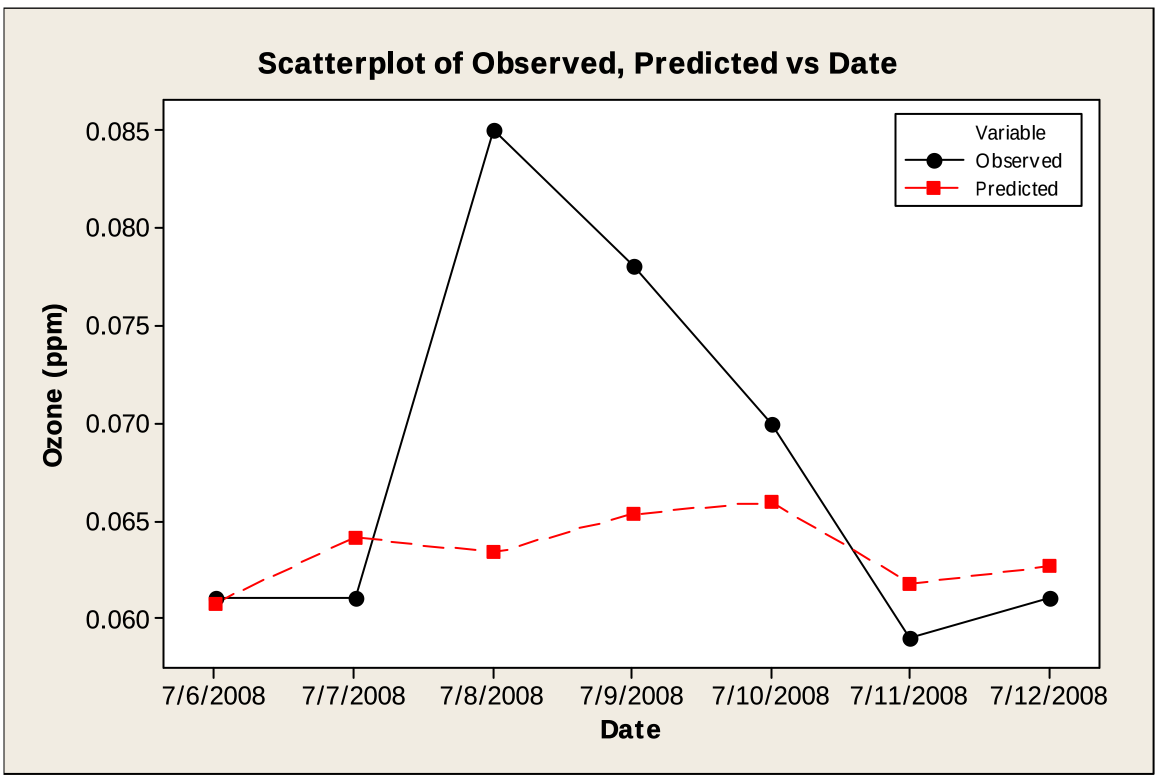

Figure 30. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.021 ppm, for July 8, 2008 to the event. If not for the event the Ozone concentration at the Hawthorne monitor would have remained below the NAAQS.

Harrisville - HV - 49-057-1003

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 12-years of historical data from the Harrisville monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 2001 through 2008 were included.

- Data from the Harrisville monitor since 2001 shows that ozone concentration of these dates were above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 96.8 %ile and July 9, 2008 in the 95.8 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.057
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.203
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.069
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.083
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.100

- Figure 31 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

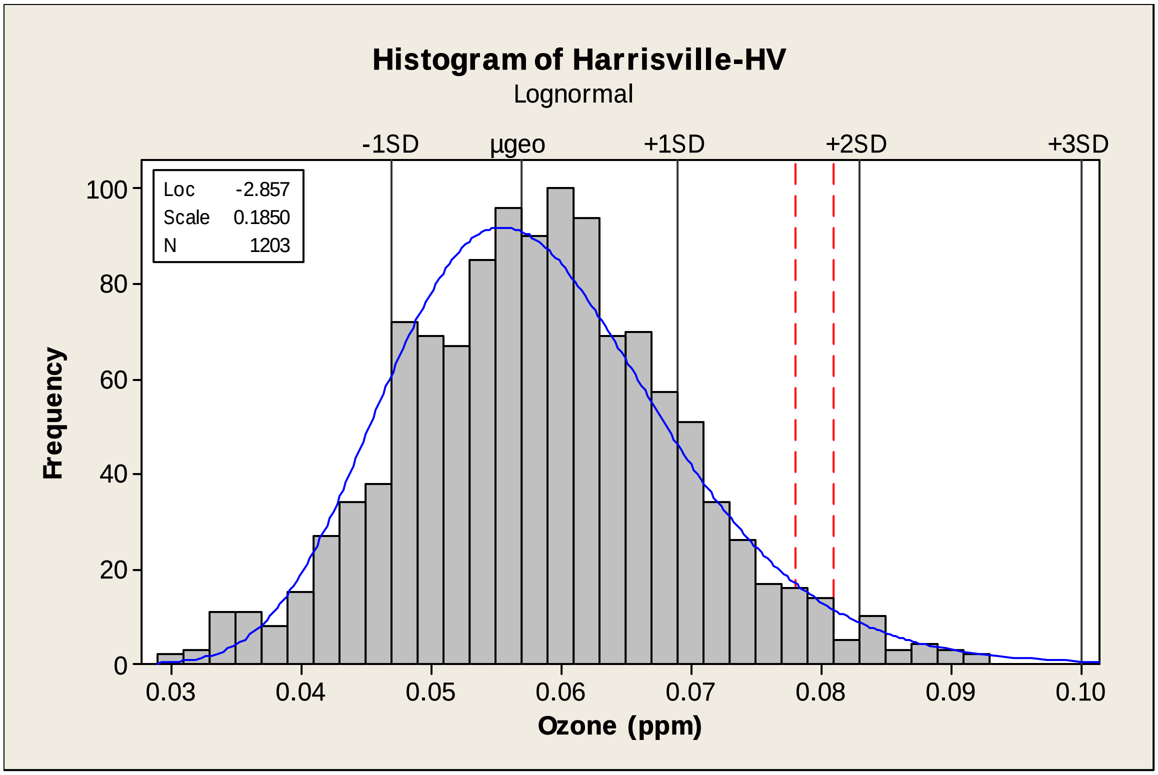

Figure 31. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 2001-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.081 ppm and 0.078ppm.
- The difference between the measured concentration and the Geometric Mean is 0.024 ppm and 0.021 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Harrisville monitoring site would then be 0.069 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.012 ppm and 0.009 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Syracuse, 49-011-6002, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 6. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 7. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.
    - Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 7. Best Subset Regression Analysis for the Harrisville Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Change	Average Wind Speed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	35.8	35.7	159.2	0.0086430			X													
1	35.3	35.2	168.6	0.0086787	X															
2	43.9	43.8	17.5	0.0080825	X											X				
2	43.3	43.2	28.0	0.0081250		X										X				
3	44.5	44.3	10.1	0.0080485	X											X				X
3	44.4	44.2	11.8	0.0080553	X						X					X				
4	44.9	44.7	4.2	0.0080200	X						X					X				X
4	44.8	44.6	5.8	0.0080266	X					X						X				X
5	45.0	44.7	4.1	0.0080156	X				X		X					X				X
5	45.0	44.7	4.4	0.0080166	X						X					X		X		X
6	45.2	44.8	3.6	0.0080091	X				X		X					X			X	X
6	45.1	44.8	3.8	0.0080101	X				X		X					X		X		X
7	45.3	44.9	3.0	0.0080027	X	X	X		X		X					X				X
7	45.3	44.9	3.3	0.0080041	X	X	X		X	X						X				X
8	45.5	45.0	2.3	0.0079957	X	X	X		X		X					X			X	X
8	45.4	45.0	2.5	0.0079966	X	X	X		X		X					X		X		X
9	45.5	45.0	3.9	0.0079980	X	X	X		X		X		X			X			X	X
9	45.5	45.0	4.0	0.0079985	X	X	X		X		X	X				X			X	X
10	45.5	45.0	5.3	0.0079998	X	X	X		X		X	X	X			X			X	X
10	45.5	44.9	5.5	0.0080006	X	X	X		X		X	X	X			X		X		X
11	45.5	44.9	7.2	0.0080033	X	X	X		X		X	X	X			X	X		X	X
11	45.5	44.9	7.2	0.0080036	X	X	X	X	X		X	X	X			X			X	X
12	45.5	44.9	9.0	0.0080069	X	X	X	X	X		X	X	X			X	X		X	X
12	45.5	44.8	9.1	0.0080073	X	X	X		X		X	X	X			X	X	X	X	X
13	45.5	44.8	11.0	0.0080109	X	X	X	X	X		X	X	X			X	X	X	X	X
13	45.5	44.8	11.0	0.0080111	X	X	X	X	X		X	X	X	X		X	X		X	X
14	45.5	44.7	13.0	0.0080151	X	X	X	X	X		X	X	X	X		X	X	X	X	X
14	45.5	44.7	13.0	0.0080151	X	X	X	X	X	X	X	X	X			X	X	X	X	X
15	45.5	44.7	15.0	0.0080192	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
15	45.5	44.7	15.0	0.0080192	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
16	45.5	44.6	17.0	0.0080233	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created:
  Predicted = 0.0927 + (0.00102 * Avg Temp) + (0.000686 * Max Temp) – (0.000823 * Avg Aft. Temp) - (0.000322 * Avg RH) + (0.00020 * RH Change) - (0.000007 * Average Windspeed) + (0.000006 * Max Wind Speed) + (0.000056 * Average Solar) - (0.000108 * MaxBP) + (0.000198 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 1203 observations from, 2001-2008, only 983 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

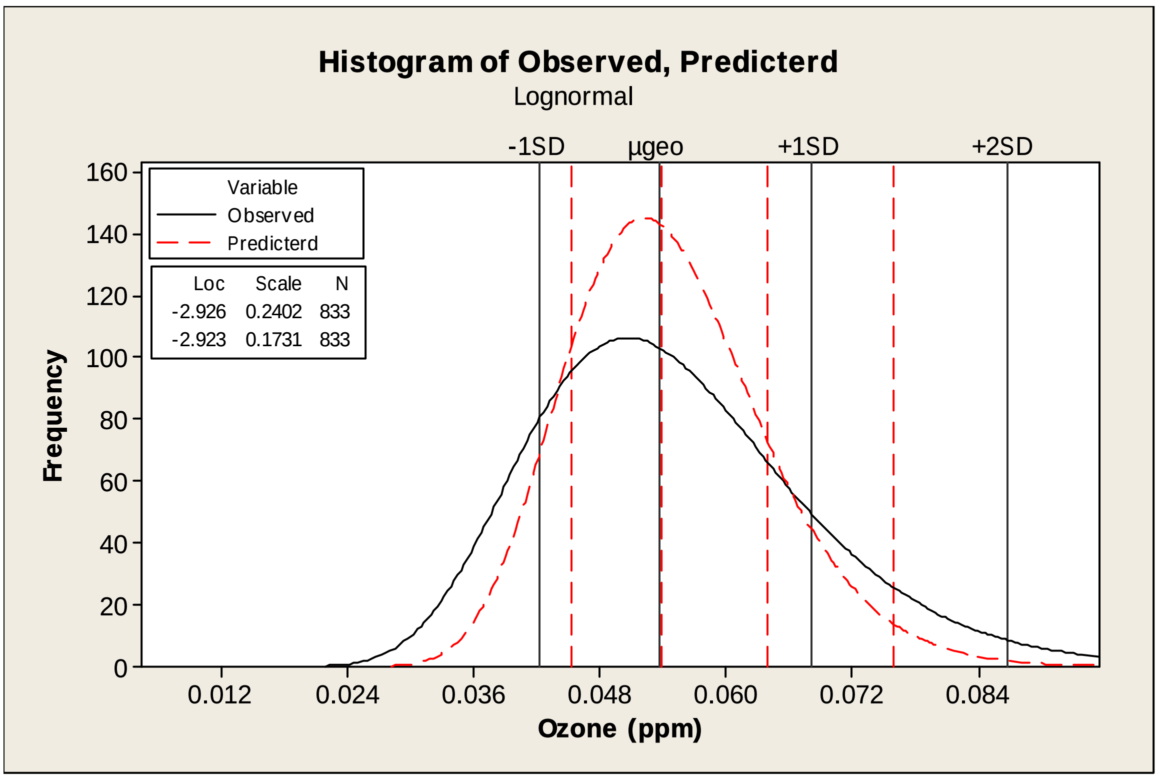

Figure 32. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 32 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

- **Table 8**. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	983	0	0.058045	0.000344	0.010780	0.029125	0.050167
Predicted	983	0	0.058578	0.000232	0.007286	0.032032	0.053566
Diff	983	0	0.000534	0.000254	0.007960	-0.026927	-0.004301

Variable	Median	Q3	Maximum
Observed	0.058000	0.065000	0.092167
Predicted	0.059872	0.064111	0.073005
Diff	0.000621	0.005806	0.027579

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.016 ppm if the observed.
  - During the event Ozone was under predicted by 0.016 ppm on July 8, 2008 and 0.008 ppm on July 9, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

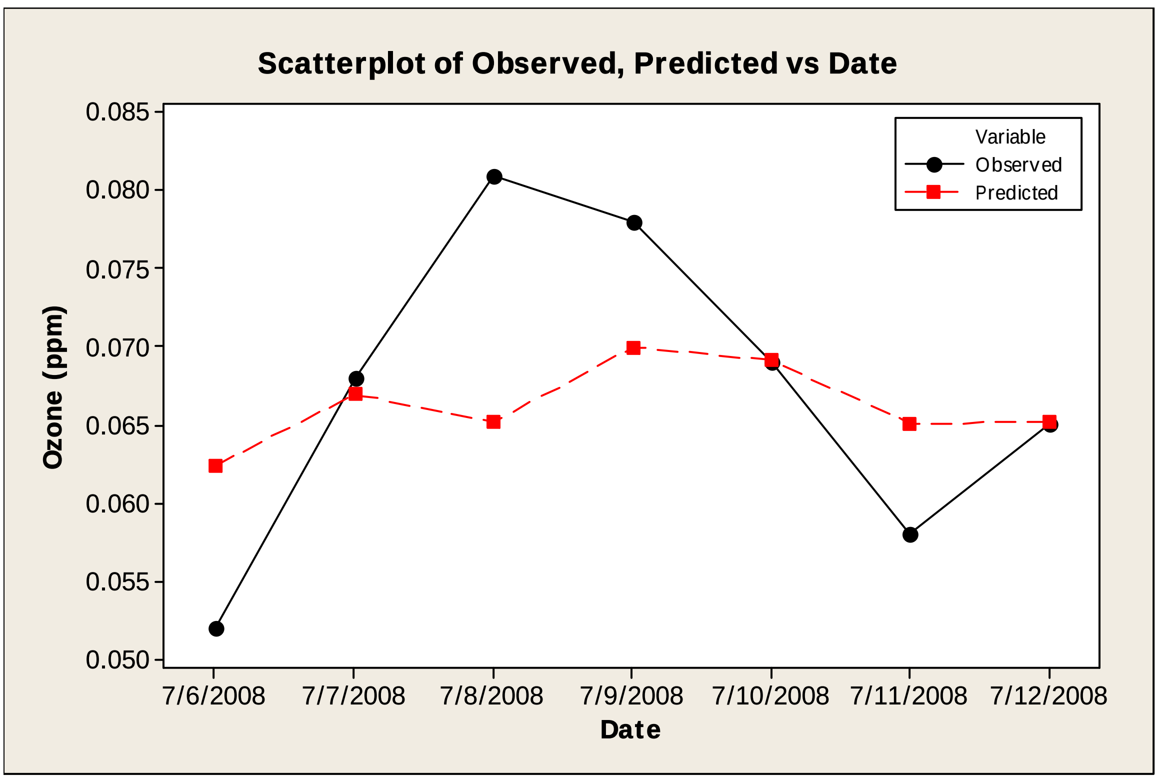

Figure 33. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.016 ppm, for July 8, 2008 and 0.008 ppm, for July 9, 2008 to the event. If not for the event the Ozone concentration at the Hawthorne monitor would have remained below the NAAQS.

Bountiful - BV - 49-011-0004

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 12-years of historical data from the Bountiful monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 2003 through 2008 were included.

- Data from the Bountiful monitor since 2003 shows that ozone concentration of these dates were above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 98.6 %ile and July 9, 2008 in the 95.8 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.055
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.245
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.068
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.085
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.106

- Figure 34 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

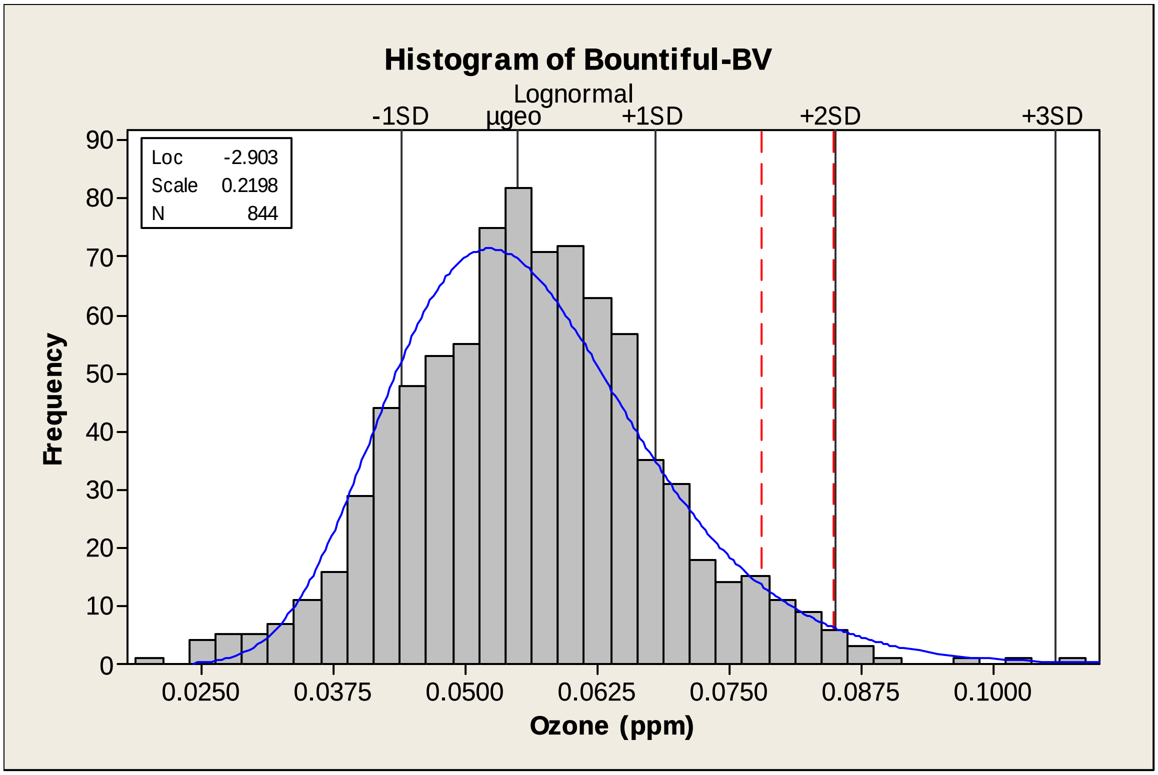

Figure 34. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 2003-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.085 ppm and 0.078ppm.
- The difference between the measured concentration and the Geometric Mean is 0.030 ppm and 0.023 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Bountiful monitoring site would then be 0.068 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.017 ppm and 0.010 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Syracuse, 49-011-6002, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 9. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 10. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.
  - Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 10. Best Subset Regression Analysis for the Bountiful Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Changed	Average Windspeed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	30.2	30.1	189.6	0.0099178	X															
1	28.3	28.2	217.1	0.010050			X													
2	40.3	40.2	42.0	0.0091737	X											X				
2	38.3	38.2	71.8	0.0093283		X										X				
3	42.6	42.4	9.9	0.0089995	X		X									X				
3	41.7	41.5	23.8	0.0090732	X					X						X				
4	43.0	42.7	6.5	0.0089763	X		X			X						X				
4	43.0	42.7	7.4	0.0089806	X		X				X					X				
5	43.3	43.0	4.3	0.0089588	X		X			X						X				X
5	43.2	42.9	5.1	0.0089630	X		X				X					X				X
6	43.4	43.0	4.2	0.0089528	X		X			X		X				X				X
6	43.4	43.0	4.9	0.0089566	X		X			X						X			X	X
7	43.5	43.1	4.7	0.0089503	X		X			X		X				X			X	X
7	43.5	43.0	5.3	0.0089534	X		X				X	X				X			X	X
8	43.7	43.1	5.0	0.0089466	X		X			X		X		X	X	X				X
8	43.6	43.1	5.4	0.0089487	X		X	X		X				X	X	X				X
9	43.8	43.2	5.2	0.0089423	X		X			X		X		X	X	X			X	X
9	43.8	43.1	5.6	0.0089446	X		X	X		X		X		X	X	X				X
10	43.9	43.2	6.1	0.0089415	X		X	X		X		X		X	X	X			X	X
10	43.8	43.1	6.7	0.0089448	X		X	X			X	X		X	X	X			X	X
11	43.9	43.1	7.7	0.0089447	X	X	X	X		X		X		X	X	X			X	X
11	43.9	43.1	7.8	0.0089456	X		X	X		X		X		X	X	X		X	X	X
12	43.9	43.1	9.4	0.0089487	X	X	X	X		X		X		X	X	X		X	X	X
12	43.9	43.1	9.5	0.0089493	X	X	X	X		X		X		X	X	X	X		X	X
13	43.9	43.0	11.3	0.0089533	X	X	X	X		X		X		X	X	X	X	X	X	X
13	43.9	43.0	11.4	0.0089538	X	X	X	X		X	X	X		X	X	X		X	X	X
14	43.9	43.0	13.2	0.0089583	X	X	X	X	X	X	X	X		X	X	X		X	X	X
14	43.9	43.0	13.2	0.0089584	X	X	X	X	X	X		X		X	X	X	X	X	X	X
15	43.9	42.9	15.0	0.0089628	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
15	43.9	42.9	15.2	0.0089635	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
16	43.9	42.8	17.0	0.0089681	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created: Predicted = 0.0858 + (0.00246 * Avg Temp) - (0.00151 * Avg Aft. Temp) +(0.000246 * Temp Change) + (0.000161 * Max RH) - (0.000016 * Average Windspeed) - (0.000117 * Max Wind St Dev Hz) + (0.000153 * Average Wind St Dev Hz) + (0.000078 * Average Solar) - (0.000103 * MaxBP) + (0.000169 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 844 observations from, 2003-2008, only 843 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

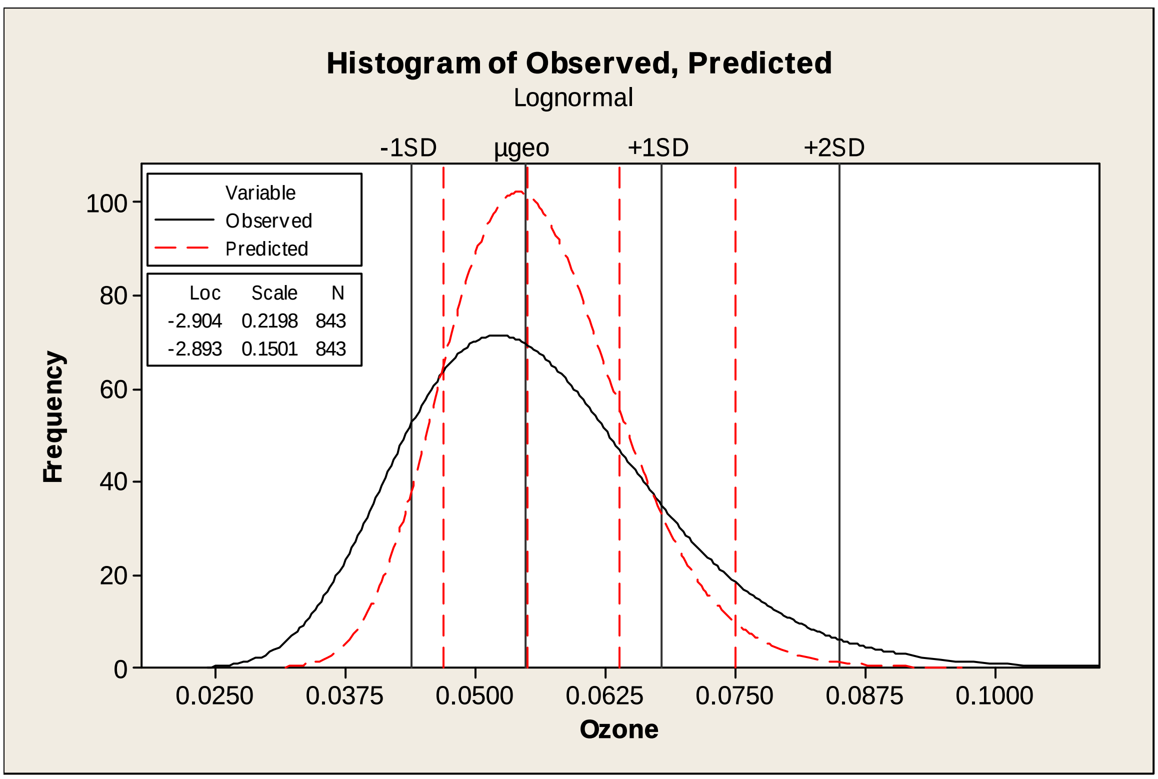

Figure 35. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 35 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 11. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	843	0	0.056112	0.000409	0.011862	0.020625	0.048000
Predicted	843	0	0.056029	0.000272	0.007892	0.030273	0.050311
Diff	843	0	-0.000083	0.000306	0.008888	-0.041889	-0.005519

Variable	Median	Q3	Maximum
Observed	0.055625	0.063125	0.108375
Predicted	0.057557	0.062268	0.071645
Diff	0.000302	0.006173	0.025789

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.018 ppm if the observed.
  - During the event Ozone was under predicted by 0.015 ppm on July 8, 2008 and 0.008 ppm on July 9, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

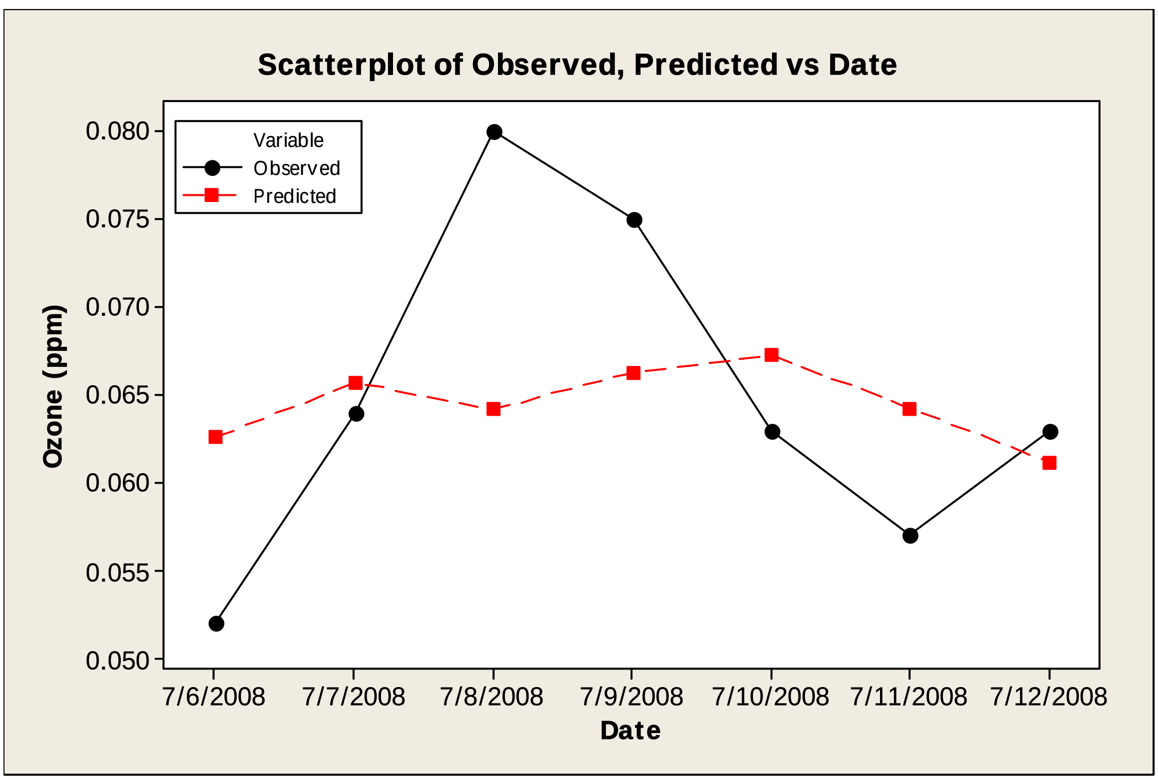

Figure 36. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.015 ppm, for July 8, 2008 and 0.008 ppm, for July 9, 2008 to the event. If not for the event the Ozone concentration at the Hawthorne monitor would have remained below the NAAQS.

Hawthorne - HW - 49-035-3006

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 12-years of historical data from the Hawthorne monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 1997 through 2008 were included.

- Data from the Hawthorne monitor since 1997 shows that ozone concentration of these dates were above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 97.3 %ile and July 9, 2008 in the 95.8 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.052
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.278
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.067
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.086
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.110

- Figure 37 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

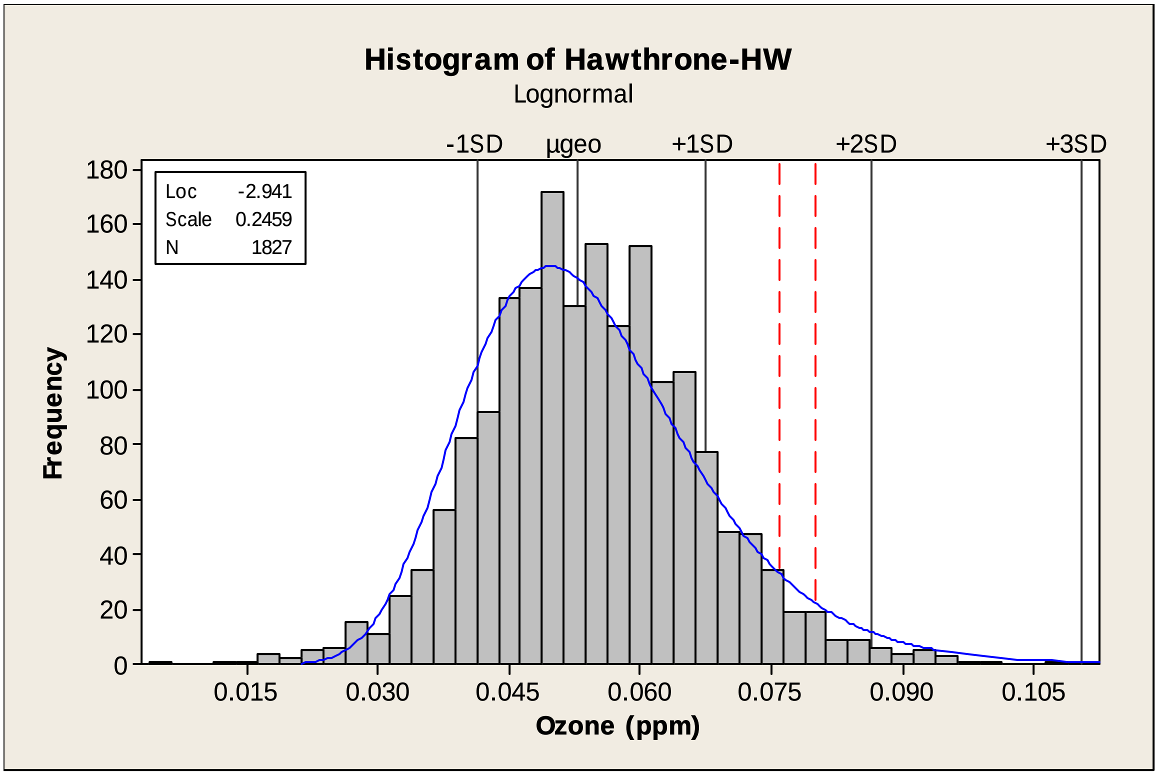

Figure 37. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 1997-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.080 ppm and 0.076ppm.
- The difference between the measured concentration and the Geometric Mean is 0.028 ppm and 0.024 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Hawthorne monitoring site would then be 0.067 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.013 ppm and 0.009 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Saltair, 49-035-3005, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 12. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 13. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.
  - Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 13. Best Subset Regression Analysis for the Hawthorne Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Changed	Average Windspeed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Max Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	34.5	34.4	339.2	0.0097492			X														
1	33.1	33.1	363.2	0.0098489												X					
2	47.1	47.0	116.3	0.0087658	X											X					
2	46.4	46.2	129.6	0.0088274	X													X			
3	50.9	50.7	51.2	0.0084534	X				X							X					
3	49.8	49.6	70.3	0.0085453	X					X						X					
4	52.4	52.1	26.4	0.0083282	X				X			X				X					
4	51.8	51.5	37.1	0.0083805	X				X				X			X					
5	52.8	52.5	20.9	0.0082963	X		X		X			X				X					
5	52.6	52.3	24.8	0.0083156	X				X			X				X					X
6	53.4	53.1	11.3	0.0082440	X		X	X	X			X				X					
6	53.0	52.6	19.3	0.0082835	X		X		X			X				X					X
7	53.8	53.4	7.3	0.0082191	X	X	X	X	X			X				X					
7	53.6	53.2	11.1	0.0082384	X		X	X	X			X				X					X
8	53.9	53.4	7.4	0.0082147	X	X	X	X	X			X				X					X
8	53.9	53.4	7.6	0.0082157	X	X	X	X	X			X				X		X			
9	54.0	53.5	6.4	0.0082046	X	X	X	X	X			X				X				X	X
9	54.0	53.5	7.7	0.0082114	X	X	X	X	X			X				X			X		X
10	54.1	53.6	6.9	0.0082024	X	X	X	X	X			X				X		X		X	X
10	54.1	53.6	7.0	0.0082029	X	X	X	X	X	X		X				X				X	X
11	54.2	53.6	7.4	0.0081999	X	X	X	X	X		X	X				X		X		X	X
11	54.2	53.6	7.6	0.0082006	X	X	X	X	X	X		X				X		X		X	X
12	54.2	53.6	8.8	0.0082014	X	X	X	X	X		X	X			X	X		X		X	X
12	54.2	53.6	8.9	0.0082022	X	X	X	X	X	X		X			X	X		X		X	X
13	54.3	53.5	10.4	0.0082046	X	X	X	X	X		X	X			X	X		X	X	X	X
13	54.3	53.5	10.6	0.0082056	X	X	X	X	X	X		X			X	X		X	X	X	X
14	54.3	53.5	12.2	0.0082088	X	X	X	X	X		X	X	X		X	X		X	X	X	X
14	54.3	53.5	12.3	0.0082089	X	X	X	X	X		X	X			X	X	X	X	X	X	X
15	54.3	53.4	14.1	0.0082132	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X
15	54.3	53.4	14.1	0.0082132	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X
16	54.3	53.4	16.0	0.0082177	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
16	54.3	53.4	16.1	0.0082182	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
17	54.3	53.3	18.0	0.0082227	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created:
  - Predicted = 0.0952 + (0.00392 * Avg Temp) - (0.00115 * Max Temp) – (0.00146 * Avg Aft. Temp) + (0.00114 * Temp Change) + (0.000205 * Avg RH) - (0.000040 * RH Change) - (0.000911 * Average Windspeed) - (0.000084 * Average Wind St Dev Hz) + (0.000061 * Average Solar) + (0.000009 * Average Aft. Solar) - (0.000139 * MaxBP) + (0.000182 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 1827 observations from, 1997-2008, only 833 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

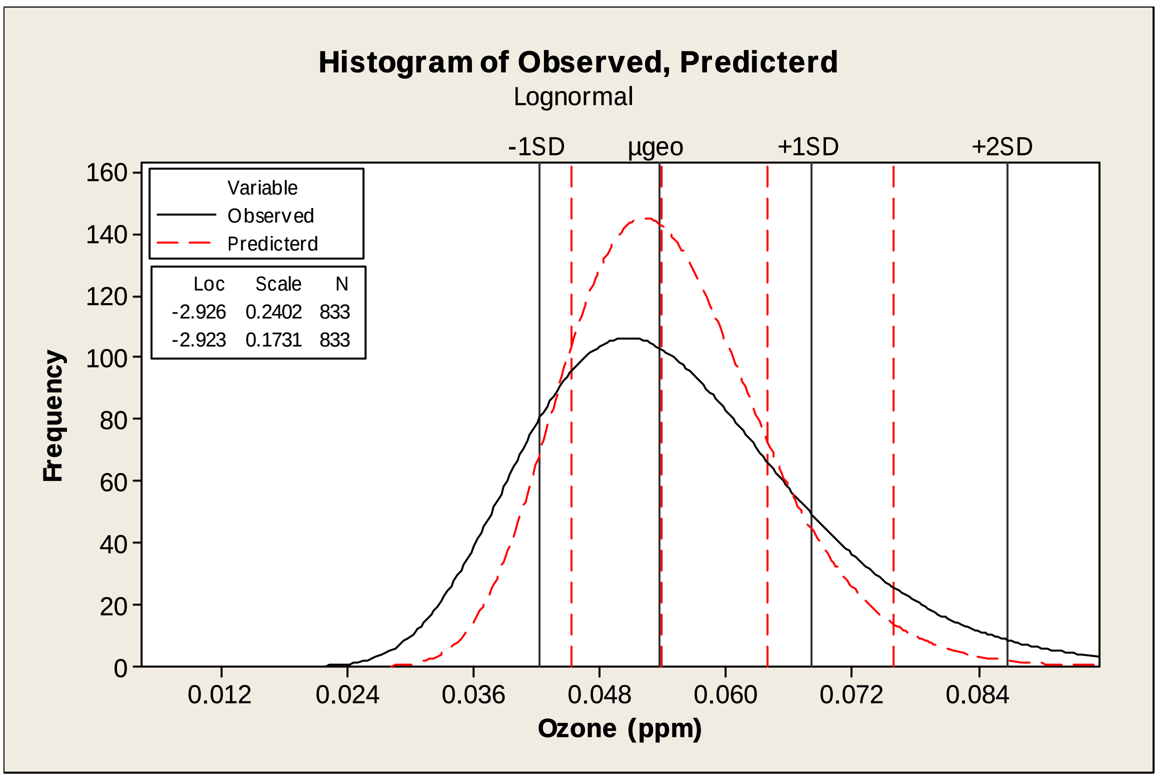

Figure 38. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 38 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 14. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	833	0	0.055065	0.000417	0.012037	0.006167	0.046750
Predicterd	833	0	0.054566	0.000305	0.008804	0.027875	0.048735
Diff	833	0	-0.000499	0.000282	0.008142	-0.024378	-0.005702

Variable	Median	Q3	Maximum
Observed	0.055000	0.063062	0.093250
Predicterd	0.055715	0.061454	0.071093
Diff	-0.000346	0.005046	0.045146

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.016 ppm if the observed.
  - During the event Ozone was under predicted by 0.019 ppm on July 8, 2008 and 0.010 ppm on July 9, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

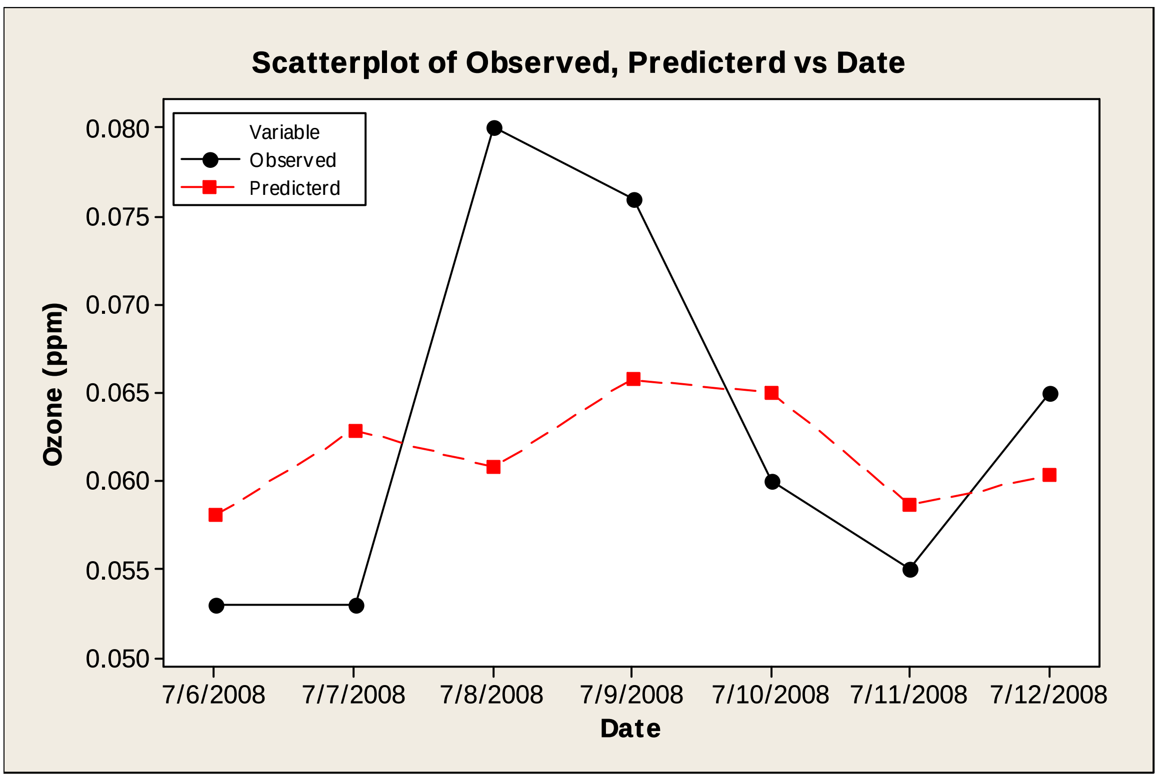

Figure 39. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.019 ppm, for July 8, 2008 and 0.010 ppm, for July 9, 2008 to the event. If not for the event the Ozone concentration at the Hawthorne monitor would have remained below the NAAQS.

Beach – B4 - 49-035-2004

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 15-years of historical data from the Beach monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 1994 through 2008 were included.

- Data from the Beach monitor since 1994 shows that ozone concentration of this date was above the 93 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 93.3 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.057
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.226
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.070
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.086
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.105

- Figure 40 is a histogram of the historical ozone values. The event value is marked with a red dashed line. The blue line is a fitted line overlay of a lognormal distribution.

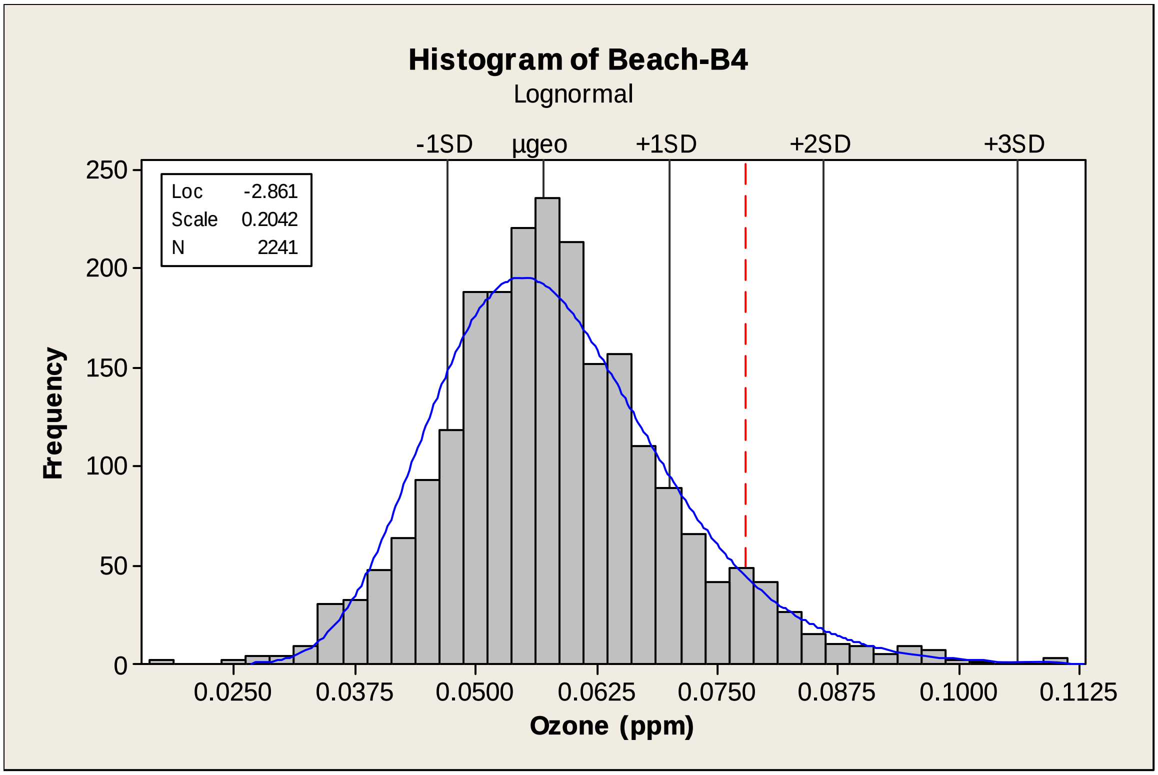

Figure 40. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 1994-2008, July 8th 2008 value marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.078 ppm.
- The difference between the measured concentration and the Geometric Mean is 0.021 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Beach monitoring site would then be 0.070 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.008 ppm.

“But for” the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah’s monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Saltair, 49-035-3005, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.
- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 15. Table of variables considered for regression analysis and their description.

Variable Calculation	**Description**
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 16. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.
- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.
  - Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 16. Best Subset Regression Analysis for the Beach Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Change	Average Wind speed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Avg BP	Max BP	Diff BP
1	23.9	23.8	141.6	0.0099794	X													
1	23.9	23.8	142.3	0.0099831		X												
2	30.4	30.2	61.3	0.0095496	X										X			
2	28.5	28.3	86.0	0.0096824		X									X			
3	34.0	33.8	17.8	0.0093054	X			X							X			
3	32.8	32.5	33.1	0.0093901	X				X						X			
4	34.6	34.3	11.8	0.0092662	X			X							X			X
4	34.5	34.2	13.8	0.0092778	X			X							X		X	
5	34.8	34.4	12.2	0.0092632	X			X					X		X			X
5	34.7	34.3	12.8	0.0092664	X	X		X							X			X
6	35.1	34.6	9.6	0.0092430	X	X	X	X							X			X
6	35.1	34.6	10.4	0.0092472	X	X	X	X							X		X	
7	35.3	34.8	9.1	0.0092344	X	X	X	X		X					X			X
7	35.3	34.7	9.8	0.0092384	X	X	X	X		X					X		X	
8	35.4	34.8	9.8	0.0092328	X	X	X	X		X			X		X			X
8	35.4	34.8	10.0	0.0092338	X	X	X	X		X		X			X			X
9	35.6	34.9	9.8	0.0092269	X	X	X	X		X					X	X	X	X
9	35.6	34.8	10.2	0.0092292	X	X	X	X		X		X	X		X			X
10	35.7	34.9	10.1	0.0092233	X	X	X	X		X		X			X	X	X	X
10	35.7	34.9	10.5	0.0092256	X	X	X	X		X			X		X	X	X	X
11	35.9	35.0	10.4	0.0092190	X	X	X	X		X		X	X		X	X	X	X
11	35.8	34.9	11.4	0.0092251	X	X	X	X		X			X	X	X	X	X	X
12	35.9	34.9	11.9	0.0092218	X	X	X	X		X		X	X	X	X	X	X	X
12	35.9	34.9	12.0	0.0092223	X	X	X	X	X	X		X	X		X	X	X	X
13	35.9	34.9	13.4	0.0092249	X	X	X	X		X	X	X	X	X	X	X	X	X
13	35.9	34.9	13.4	0.0092250	X	X	X	X	X	X		X	X	X	X	X	X	X
14	36.0	34.9	15.0	0.0092283	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created:
  Predicted = 0.0320 + (0.00209 * Avg Temp) - (0.000953 * Avg Aft. Temp) + (0.000555 * Temp Change) + (0.000237 * Avg RH) - (0.000063 * RH Change) - (0.000128 * Max Wind Speed) - (0.000038 * Max Wind St Dev Hz)+ (0.000063 * Average Solar) + (0.000323 * AvgBP) - (0.000361 * MaxBP) + (0.000344 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 2241 observations from, 1994-2008, only 826 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

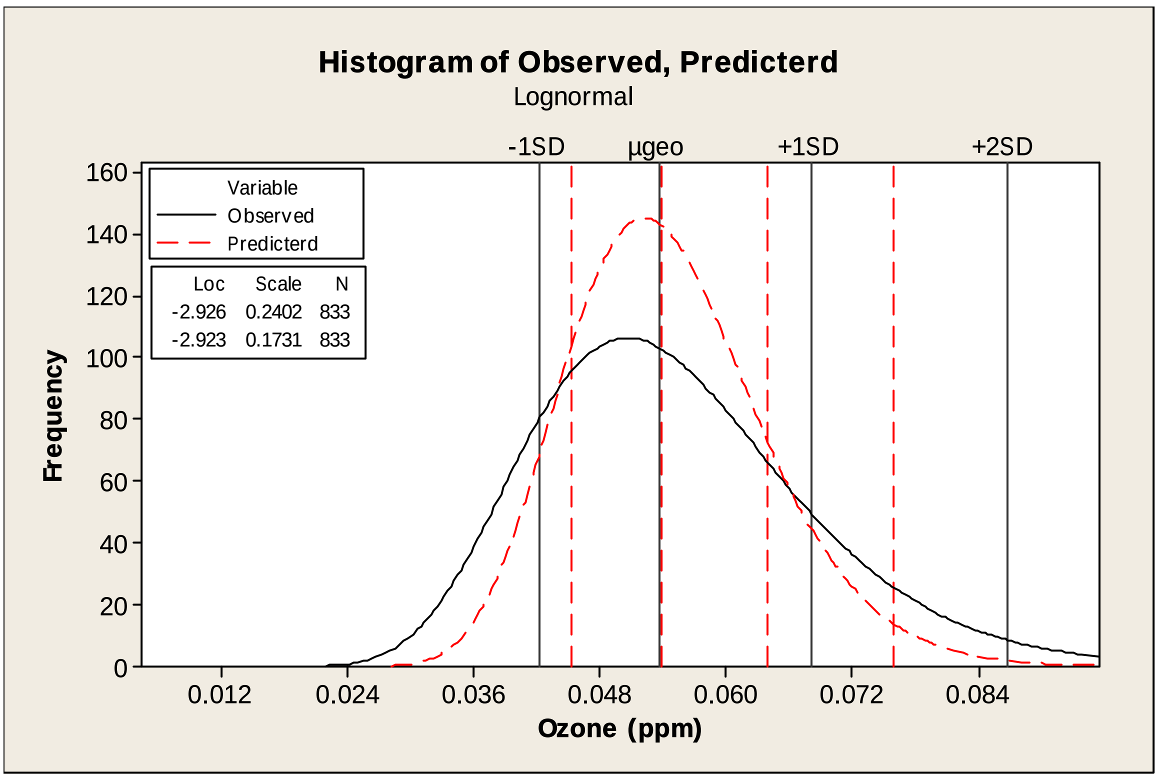

Figure 41. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 41 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 17. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	826	0	0.058120	0.000398	0.011433	0.017875	0.050969
Predicted	826	0	0.058363	0.000239	0.006871	0.038143	0.053429
Diff	826	0	0.000243	0.000319	0.009157	-0.030401	-0.005699

Variable	Median	Q3	Maximum
Observed	0.057625	0.065312	0.095625
Predicted	0.059356	0.063778	0.074519
Diff	0.000676	0.006849	0.027838

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.018 ppm if the observed.
  - During the event Ozone was under predicted by 0.016 ppm on July 8, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

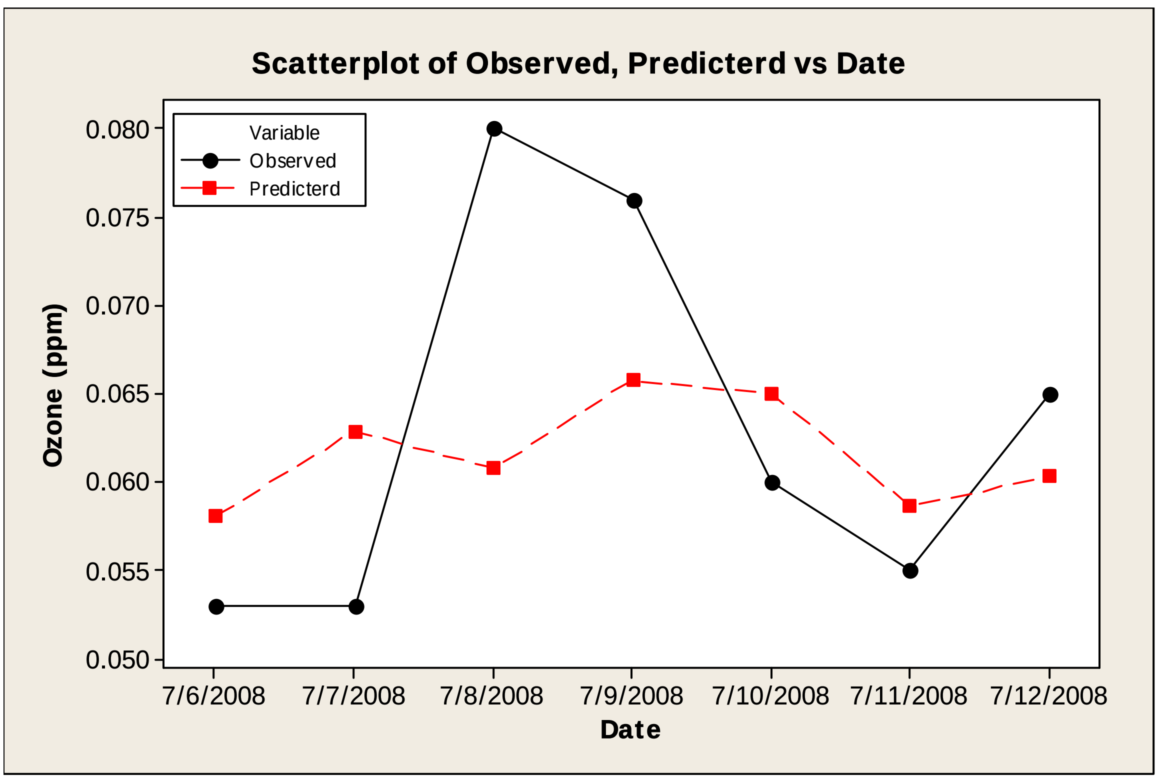

Figure 42. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.016 ppm, for July 8, 2008 to the event. If not for the event the Ozone concentration at the Beach monitor would have remained below the NAAQS.

Cottonwood - CW - 49-035-0003

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 16-years of historical data from the Cottonwood monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 1993 through 2008 were included.

- Data from the Cottonwood monitor since 1993 shows that ozone concentration of these dates were above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 98.4 %ile and July 9, 2008 in the 98.7 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.054
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.272
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.069
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.088
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.112

- Figure 43 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

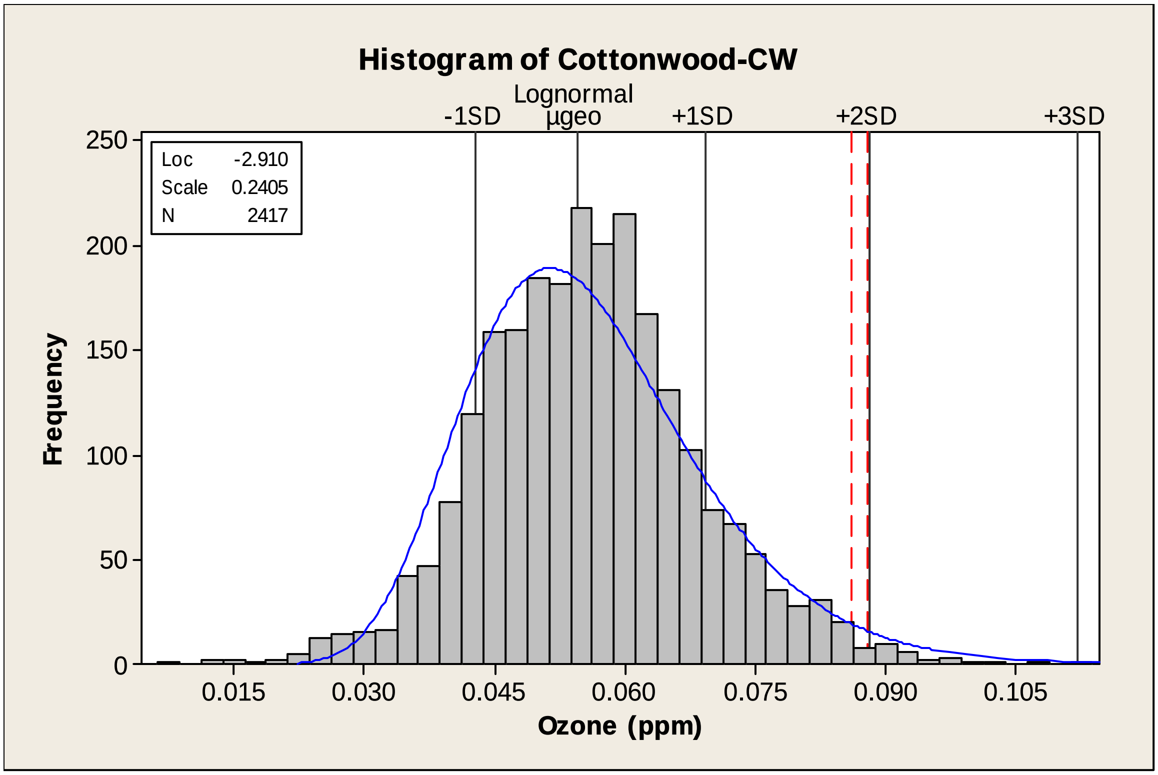

Figure 43. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 1993-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.086 ppm and 0.088ppm.
- The difference between the measured concentration and the Geometric Mean is 0.032 ppm and 0.034 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Cottonwood monitoring site would then be 0.069 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.017 ppm and 0.019 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Saltair, 49-035-3005, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 18. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 19. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.

  – Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 19. Best Subset Regression Analysis for the Cottonwood Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Change	Average Windspeed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Max Solar	Average Aft. Solar	Avg BP	Max BP	Min BP
1	35.2	35.1	325.7	0.0097258			X														
1	33.8	33.7	349.9	0.0098272												X					
2	47.9	47.7	102.1	0.0087264	X											X					
2	47.0	46.9	117.7	0.0087997		X										X					
3	50.0	49.8	66.0	0.0085502	X				X							X					
3	49.5	49.3	74.6	0.0085916	X					X						X					
4	50.9	50.7	52.4	0.0084800	X				X			X				X					
4	50.6	50.3	58.3	0.0085089	X					X		X				X					
5	51.7	51.4	39.5	0.0084124	X				X			X				X					X
5	51.3	51.0	46.7	0.0084475	X					X		X				X					X
6	52.4	52.0	29.9	0.0083603	X		X	X	X			X				X					
6	52.3	52.0	30.6	0.0083639	X				X			X				X				X	X
7	53.0	52.6	21.4	0.0083133	X	X	X	X	X			X				X					
7	52.9	52.5	22.0	0.0083164	X		X	X	X			X				X					X
8	53.4	53.0	15.5	0.0082790	X	X	X	X	X			X				X					X
8	53.4	52.9	16.4	0.0082836	X		X	X	X			X				X				X	X
9	53.8	53.3	10.5	0.0082490	X	X	X	X	X			X				X				X	X
9	53.8	53.2	11.5	0.0082540	X		X	X		X	X	X				X				X	X
10	54.0	53.5	8.9	0.0082361	X	X	X	X	X		X	X				X				X	X
10	54.0	53.4	9.0	0.0082366	X	X	X	X		X	X	X				X				X	X
11	54.2	53.6	6.9	0.0082207	X	X	X	X		X	X	X				X		X		X	X
11	54.2	53.6	7.6	0.0082242	X	X	X	X	X		X	X				X		X		X	X
12	54.3	53.6	8.6	0.0082241	X	X	X	X	X	X	X	X				X		X		X	X
12	54.3	53.6	8.6	0.0082243	X	X	X	X		X	X	X	X			X		X		X	X
13	54.3	53.5	10.3	0.0082278	X	X	X	X	X	X	X	X	X			X		X		X	X
13	54.3	53.5	10.4	0.0082284	X	X	X	X	X	X	X	X				X		X	X	X	X
14	54.3	53.5	12.2	0.0082322	X	X	X	X	X	X	X	X	X			X		X	X	X	X
14	54.3	53.5	12.2	0.0082324	X	X	X	X	X	X	X	X	X		X	X		X		X	X
15	54.3	53.4	14.1	0.0082368	X	X	X	X	X	X	X	X	X		X	X		X	X	X	X
15	54.3	53.4	14.2	0.0082371	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
16	54.3	53.4	16.0	0.0082416	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
16	54.3	53.4	16.0	0.0082416	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
17	54.3	53.3	18.0	0.0082464	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created:
  - Predicted = 0.146 + (0.00383 * Avg Temp) – (0.00108 * Max Temp) – (0.00159 * Avg Aft. Temp) + (0.00141 * Temp Change) + (0.000184 * Max RH) – (0.000194 * RH Change) – (0.000768 * Average Windspeed) + (0.000077 * Max Wind Speed) + (0.000057 * Average Solar) + (0.000012 * Average Aft. Solar) + (0.000085 * MaxBP) - (0.000299 * MinBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 2417 observations from, 1993-2008, only 841 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

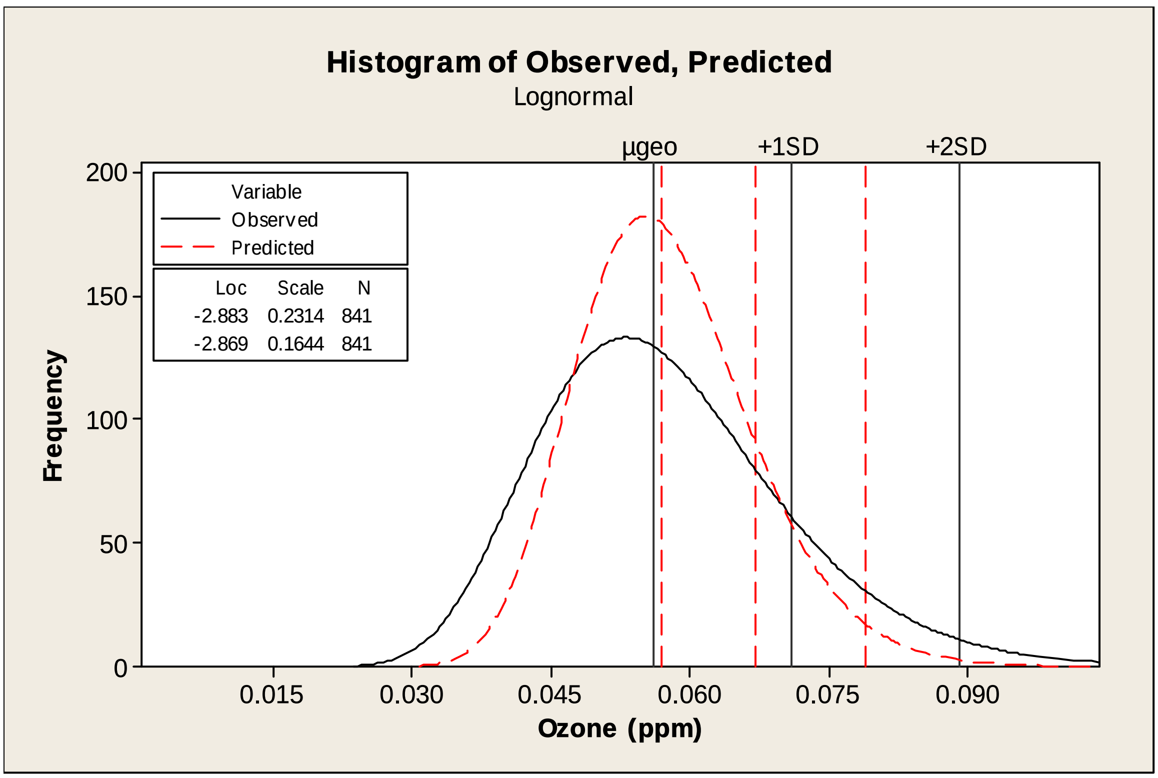

Figure 44. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 44 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 20. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	841	0	0.057375	0.000416	0.012076	0.006500	0.049250
Predicted	841	0	0.057484	0.000305	0.008832	0.032408	0.051763
Difference	841	0	0.000109	0.000281	0.008162	-0.026641	-0.005091

Variable	Median	Q3	Maximum
Cottonwood-CW	0.057250	0.065000	0.100875
Predicted	0.058633	0.064033	0.074234
Difference	0.000601	0.005687	0.039709

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.016 ppm if the observed.
  - During the event Ozone was under predicted by 0.022 ppm on July 8, 2008 and 0.016 ppm on July 9, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

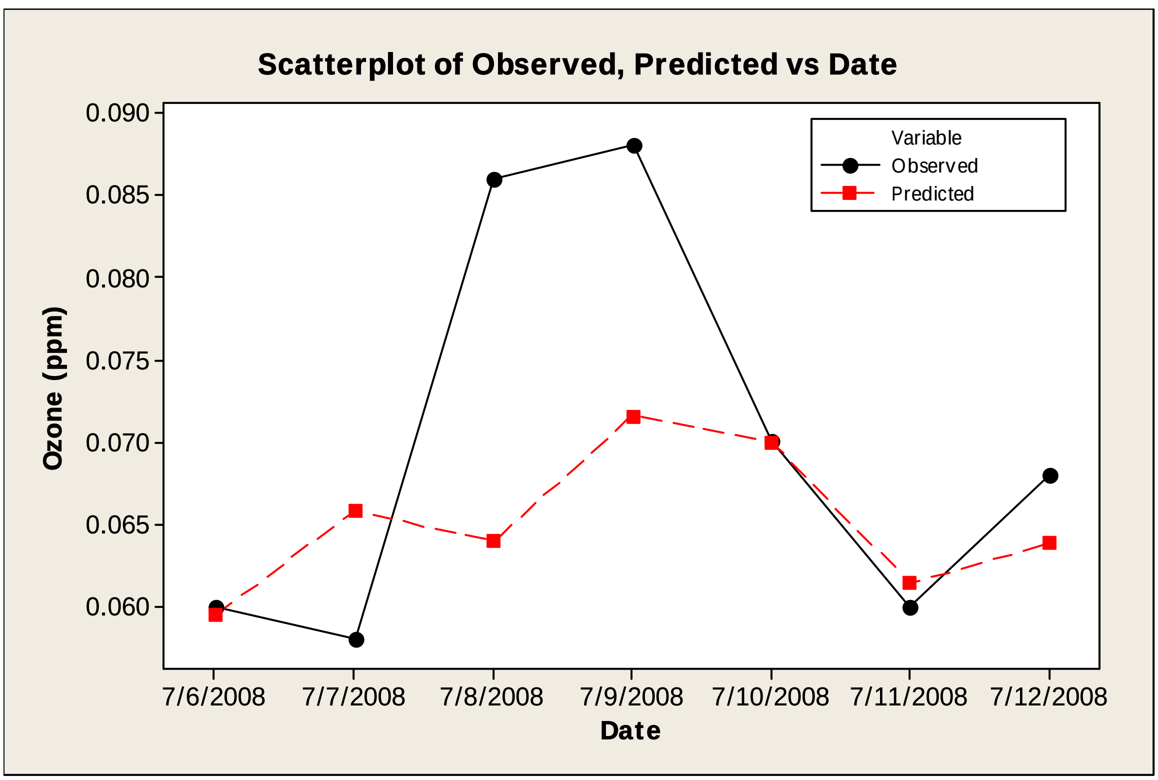

Figure 45. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.022 ppm, for July 8, 2008 and 0.016 ppm, for July 9, 2008 to the event. If not for the event the Ozone concentration at the Cottonwood monitor would have remained below the NAAQS.

Tooele – T3 - 49-045-0003

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 4-years of historical data from the Tooele monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 2005 through 2008 were included. The Tooele monitor was established in 2005.

- Data from the Tooele monitor since 2005 shows that ozone concentration of this date was above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 97.7 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.055
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.186
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.065
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.078
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.092

- Figure 46 is a histogram of the historical ozone values. The event value is marked with a red dashed line. The blue line is a fitted line overlay of a lognormal distribution.

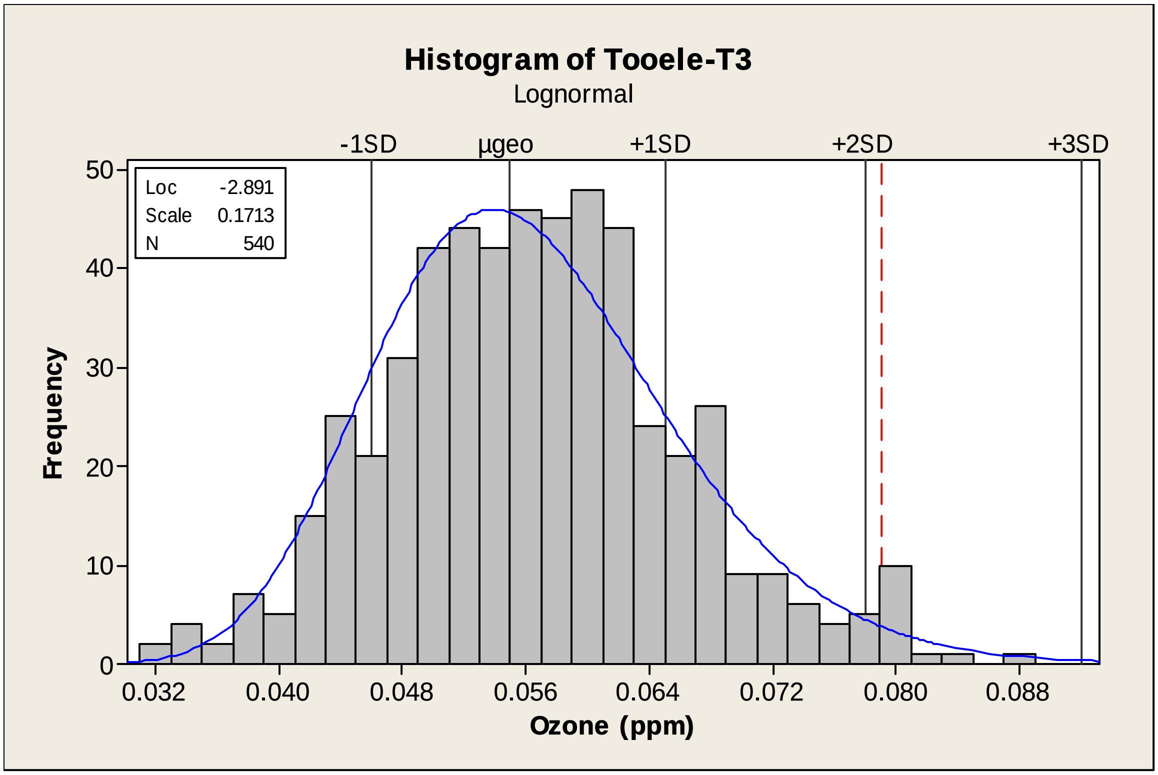

Figure 46. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 2005-2008, July 8th 2008 value marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.079 ppm.
- The difference between the measured concentration and the Geometric Mean is 0.024 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Cottonwood monitoring site would then be 0.065 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.014 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Saltair, 49-035-3005, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.
- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 21. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 22. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.

  – Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 22. Best Subset Regression Analysis for the Cottonwood Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Changed	Average Windspeed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	34.5	34.3	105.6	0.0078294			X													
1	33.0	32.9	118.1	0.0079151		X														
2	40.3	40.1	56.8	0.0074806		X											X			
2	40.2	39.9	58.1	0.0074902		X										X				
3	43.7	43.3	29.8	0.0072760		X			X							X				
3	42.9	42.6	36.0	0.0073221		X			X								X			
4	45.2	44.7	18.2	0.0071826	X			X	X							X				
4	45.0	44.5	20.2	0.0071971	X			X	X								X			
5	45.8	45.3	14.8	0.0071488	X			X	X		X					X				
5	45.8	45.2	15.4	0.0071534	X			X		X	X					X				
6	46.6	45.9	10.2	0.0071062	X		X	X		X	X						X			
6	46.4	45.7	11.8	0.0071190	X	X		X	X		X					X				
7	47.1	46.3	7.8	0.0070803	X	X	X	X	X		X						X			
7	47.1	46.2	8.2	0.0070837	X		X	X		X	X			X			X			
8	47.5	46.5	6.7	0.0070645	X	X	X	X	X		X			X			X			
8	47.4	46.5	7.0	0.0070663	X		X	X		X	X	X			X		X			
9	47.8	46.7	6.0	0.0070508	X	X	X	X	X		X	X			X		X			
9	47.7	46.7	6.6	0.0070558	X	X	X	X		X	X	X			X		X			
10	47.9	46.8	6.9	0.0070501	X	X	X	X	X		X	X			X	X	X			
10	47.8	46.7	7.6	0.0070556	X	X	X	X	X		X	X		X	X		X			
11	47.9	46.7	8.5	0.0070551	X	X	X	X	X		X	X		X	X	X	X			
11	47.9	46.7	8.6	0.0070555	X	X	X	X	X	X	X	X			X	X	X			
12	48.0	46.6	10.2	0.0070601	X	X	X	X	X	X	X	X		X	X	X	X			
12	48.0	46.6	10.4	0.0070617	X	X	X	X	X		X	X	X	X	X	X	X			
13	48.0	46.5	11.9	0.0070655	X	X	X	X	X		X	X			X	X	X	X	X	X
13	48.0	46.5	12.0	0.0070666	X	X	X	X	X	X	X	X	X	X	X	X	X			
14	48.1	46.5	13.5	0.0070703	X	X	X	X	X	X	X	X			X	X	X	X	X	X
14	48.0	46.4	13.6	0.0070709	X	X	X	X	X		X	X		X	X	X	X	X	X	X
15	48.1	46.4	15.1	0.0070751	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
15	48.1	46.3	15.4	0.0070769	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
16	48.1	46.3	17.0	0.0070820	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created: Predicted = 0.0516 + (0.00320 * Avg Temp) - (0.00125 * Max Temp) - (0.000954 * Avg Aft. Temp) + (0.00176 * Temp Change) + (0.000219 * Avg RH) - (0.000103 * RH Change) - (0.000440 * Average Windspeed) - (0.000277 * Average Wind St Dev Hz) + (0.000019 * Average Solar) + (0.000016 * Average Aft. Solar) + (0.000120 * AvgBP) - (0.000180 * MaxBP) + (0.000140 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 540 observations from, 2005-2008, only 468 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

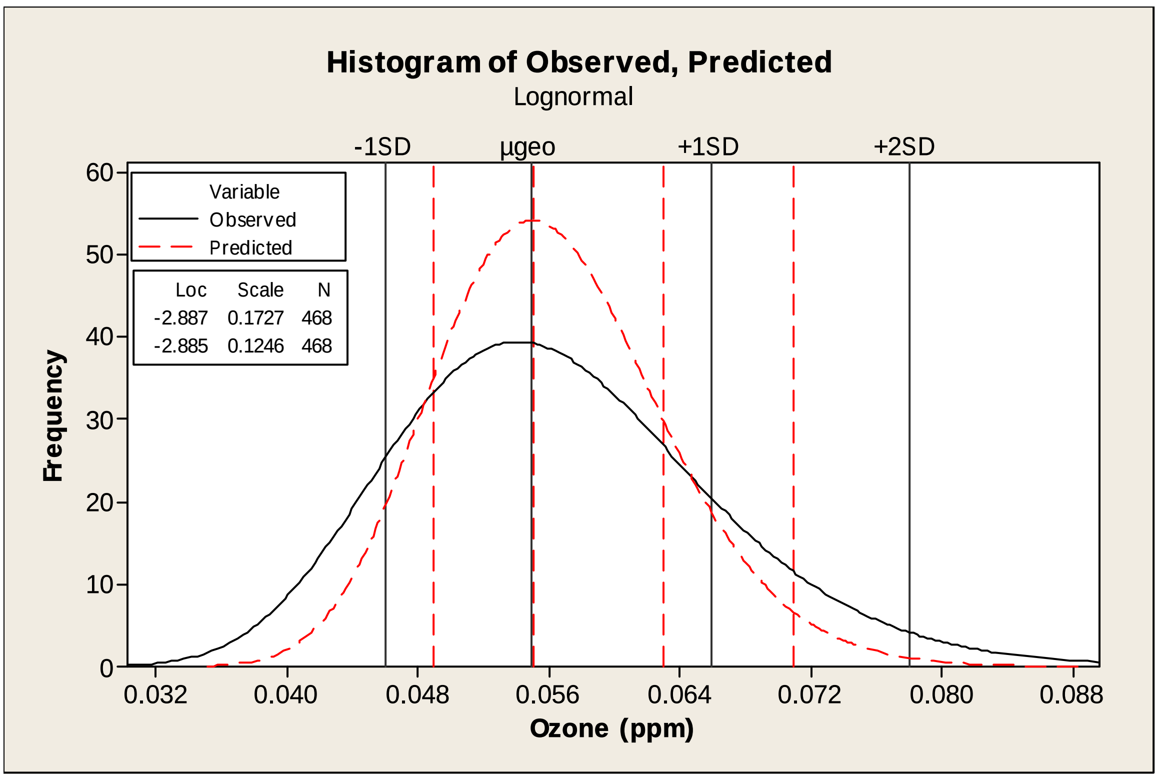

Figure 47. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 47 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 23. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	468	0	0.056586	0.000447	0.009662	0.031375	0.049750
Predicted	468	0	0.056270	0.000309	0.006693	0.033706	0.052123
Diff	468	0	-0.000317	0.000322	0.006966	-0.022811	-0.004485

Variable	Median	Q3	Maximum
Observed	0.056125	0.062223	0.087833
Predicted	0.056892	0.061221	0.069541
Diff	-0.000117	0.004145	0.024870

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.014 ppm if the observed.
  - During the event Ozone was under predicted by 0.021 ppm on July 8, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

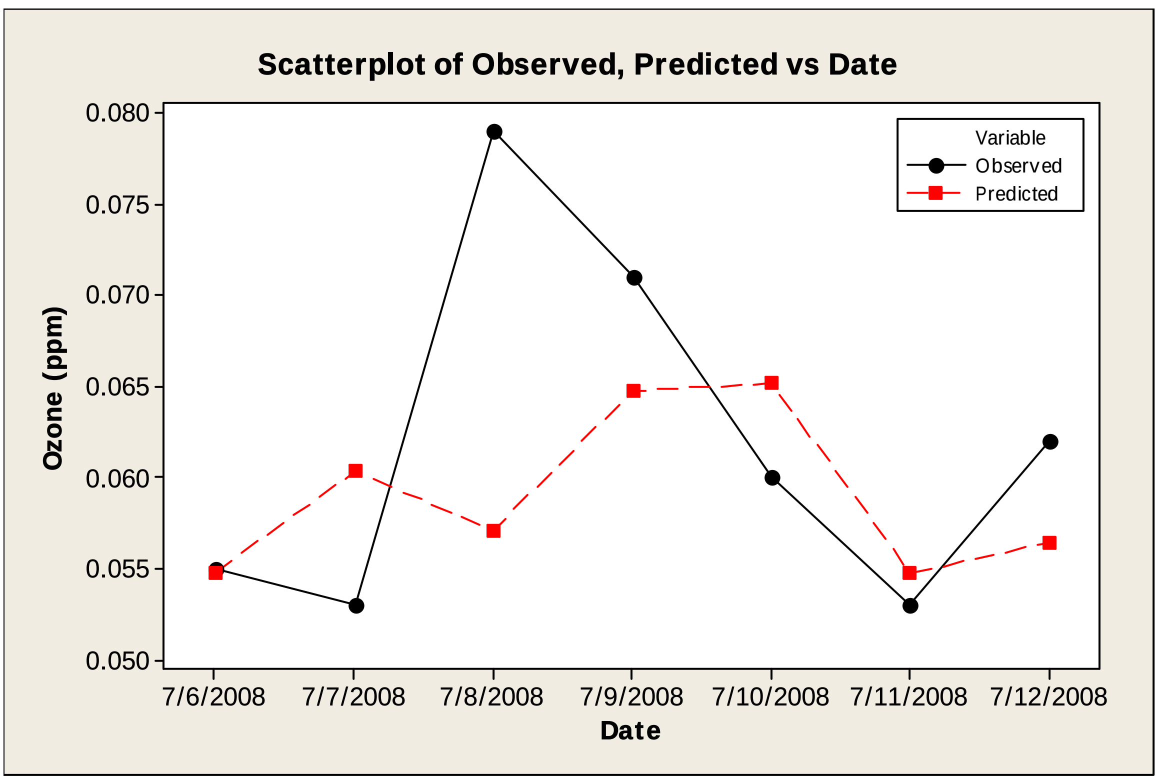

Figure 48. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.021 ppm, for July 8, 2008 to the event. If not for the event the Ozone concentration at the Tooele monitor would have remained below the NAAQS.

Highland - HG - 49-049-5008

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 14-years of historical data from the Highland monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 1995 through 2008 were included.

- Data from the Highland monitor since 1995 shows that ozone concentration of these dates were above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 99.3 %ile and July 9, 2008 in the 99.1 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.056
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.198
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.067
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.081
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.097

- Figure 49 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

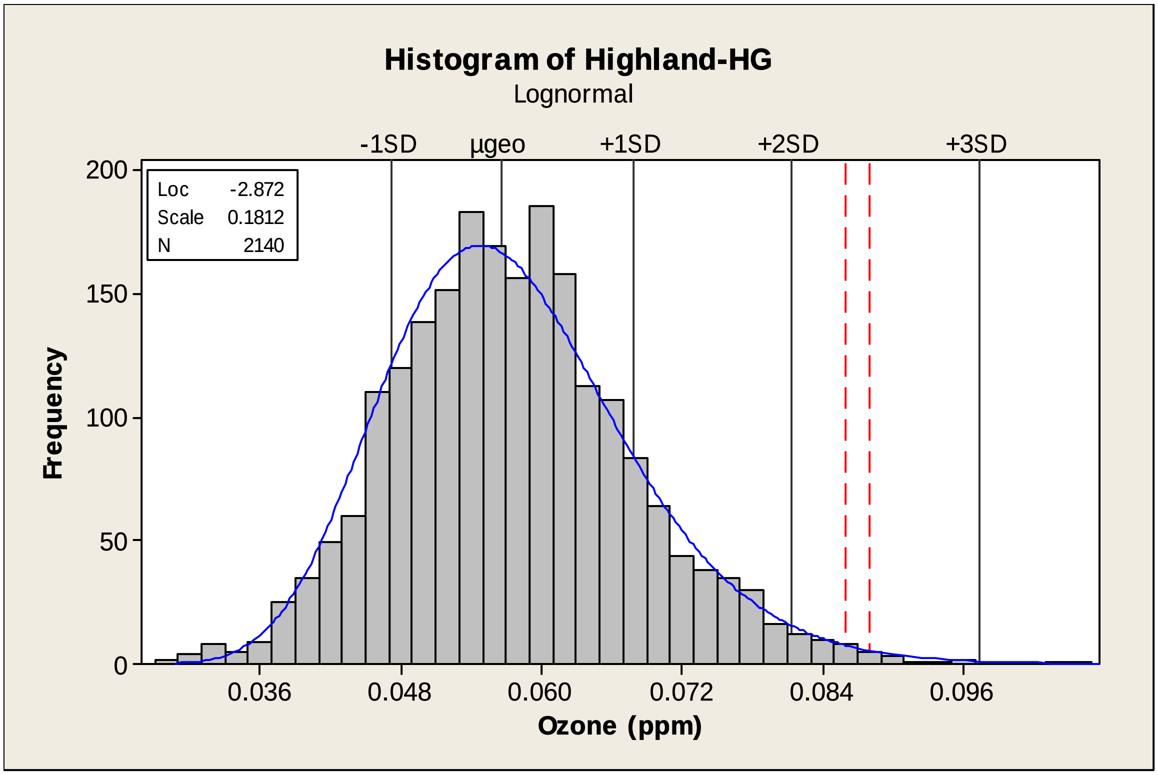

Figure 49. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 1995-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.088 ppm and 0.086ppm.
- The difference between the measured concentration and the Geometric Mean is 0.032 ppm and 0.030 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Highland monitoring site would then be 0.067 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.021 ppm and 0.019 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Saltair, 49-035-3005, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 24. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 25. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.
  - Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 25. Best Subset Regression Analysis for the Highland Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Changed	Average Wind speed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	30.2	30.2	349.1	0.0084826												X				
1	29.8	29.7	356.6	0.0085096			X													
2	41.7	41.5	158.0	0.0077608	X											X				
2	41.5	41.3	161.2	0.0077736	X												X			
3	46.4	46.2	81.0	0.0074476	X							X				X				
3	45.8	45.6	90.3	0.0074860	X							X					X			
4	48.2	47.9	51.8	0.0073226	X		X					X				X				
4	47.4	47.2	64.5	0.0073758	X		X					X					X			
5	49.0	48.7	39.5	0.0072672	X		X					X				X				X
5	48.8	48.5	43.7	0.0072846	X		X	X				X				X				
6	49.9	49.5	27.4	0.0072116	X		X					X				X			X	X
6	49.7	49.3	30.6	0.0072252	X		X					X				X		X		X
7	50.5	50.0	19.5	0.0071736	X		X					X			X	X			X	X
7	50.3	49.9	21.9	0.0071841	X		X					X		X		X			X	X
8	50.8	50.3	16.6	0.0071569	X		X	X				X			X	X			X	X
8	50.7	50.2	17.3	0.0071601	X		X	X				X			X		X		X	X
9	51.1	50.6	12.9	0.0071369	X		X	X				X			X	X	X		X	X
9	51.0	50.5	13.9	0.0071411	X	X	X	X				X			X		X		X	X
10	51.3	50.7	11.3	0.0071255	X	X	X	X				X			X	X	X		X	X
10	51.3	50.7	11.5	0.0071263	X	X	X	X	X			X			X	X			X	X
11	51.6	50.9	8.6	0.0071096	X	X	X	X	X			X			X	X	X		X	X
11	51.5	50.8	10.5	0.0071176	X	X	X	X		X		X			X	X	X		X	X
12	51.6	50.9	9.5	0.0071090	X	X	X	X	X			X		X	X	X	X		X	X
12	51.6	50.9	10.4	0.0071129	X	X	X	X	X		X	X			X	X	X		X	X
13	51.7	50.9	11.2	0.0071120	X	X	X	X	X		X	X		X	X	X	X		X	X
13	51.7	50.9	11.2	0.0071122	X	X	X	X	X	X		X		X	X	X	X		X	X
14	51.7	50.8	13.0	0.0071156	X	X	X	X	X		X	X	X	X	X	X	X		X	X
14	51.7	50.8	13.1	0.0071158	X	X	X	X	X	X		X	X	X	X	X	X		X	X
15	51.7	50.8	15.0	0.0071198	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
15	51.7	50.8	15.0	0.0071200	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
16	51.7	50.7	17.0	0.0071242	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created:
  Predicted = 0.216 + (0.00199 * Avg Temp) + (0.000267 * Max Temp) - (0.00127 * Avg Aft. Temp) + (0.000036 * Avg RH) + (0.000016 * RH Change) - (0.00149 * Average Windspeed) - (0.000027 * Max Wind St Dev Hz) - (0.000233 * Average Wind St Dev Hz) + (0.000041 * 'Average Solar') + (0.000009 * 'Average Aft. Solar') - (0.000274 * 'MaxBP') + (0.000372 * 'DiffBP')

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 2140 observations from, 1995-2008, only 833 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

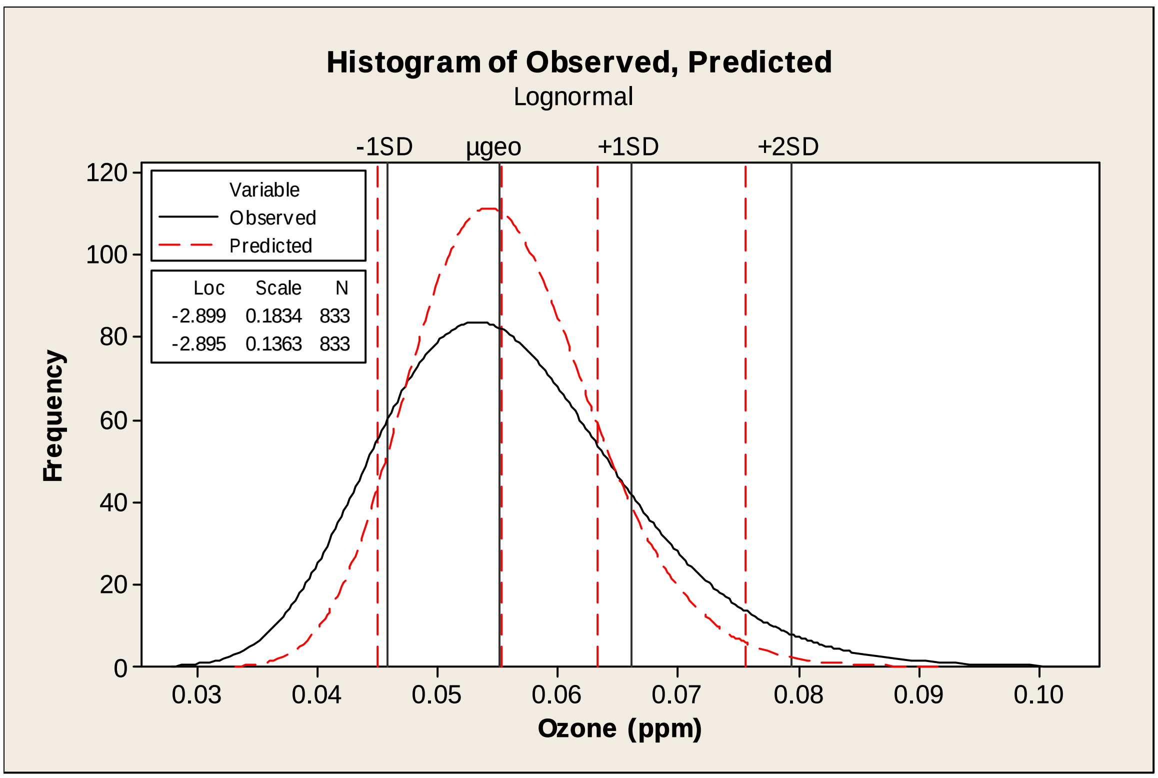

Figure 50. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 50 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 26. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	833	0	0.056011	0.000352	0.010150	0.027429	0.048937
Predicted	833	0	0.055791	0.000251	0.007240	0.034720	0.051057
Different	833	0	-0.000220	0.000246	0.007113	-0.040014	-0.004560

Variable	Median	Q3	Maximum
Observed	0.055375	0.062250	0.103500
Predicted	0.056572	0.061182	0.071456
Different	0.000197	0.004864	0.020866

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.014 ppm if the observed.
  - During the event Ozone was under predicted by 0.024 ppm on July 8, 2008 and 0.017 ppm on July 9, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

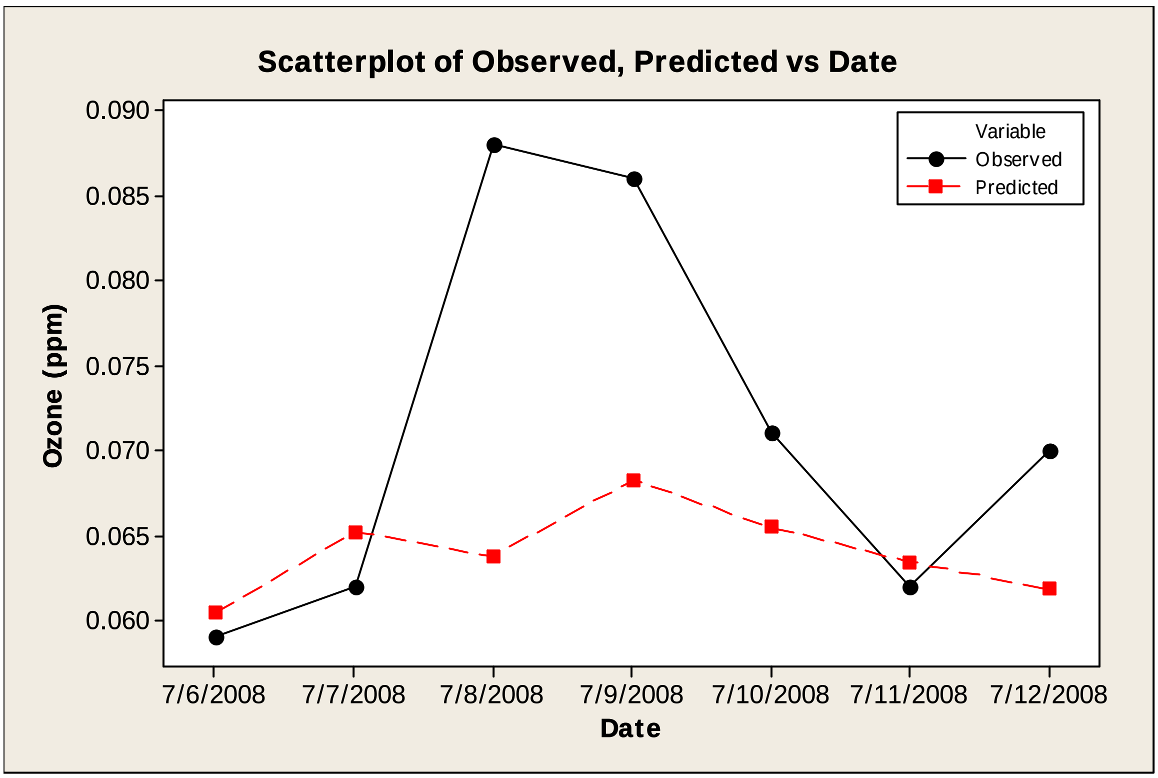

Figure 51. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.024 ppm, for July 8, 2008 and 0.017 ppm, for July 9, 2008 to the event. If not for the event the Ozone concentration at the Highland monitor would have remained below the NAAQS.

North Provo - NP - 49-049-0002

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 16-years of historical data from the North Provo monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 1993 through 2008 were included.

- Data from the Highland monitor since 1995 shows that ozone concentration of these dates were above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 99.8 %ile and July 9, 2008 in the 99.9 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.052
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.245
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.065
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.081
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.101

- Figure 52 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

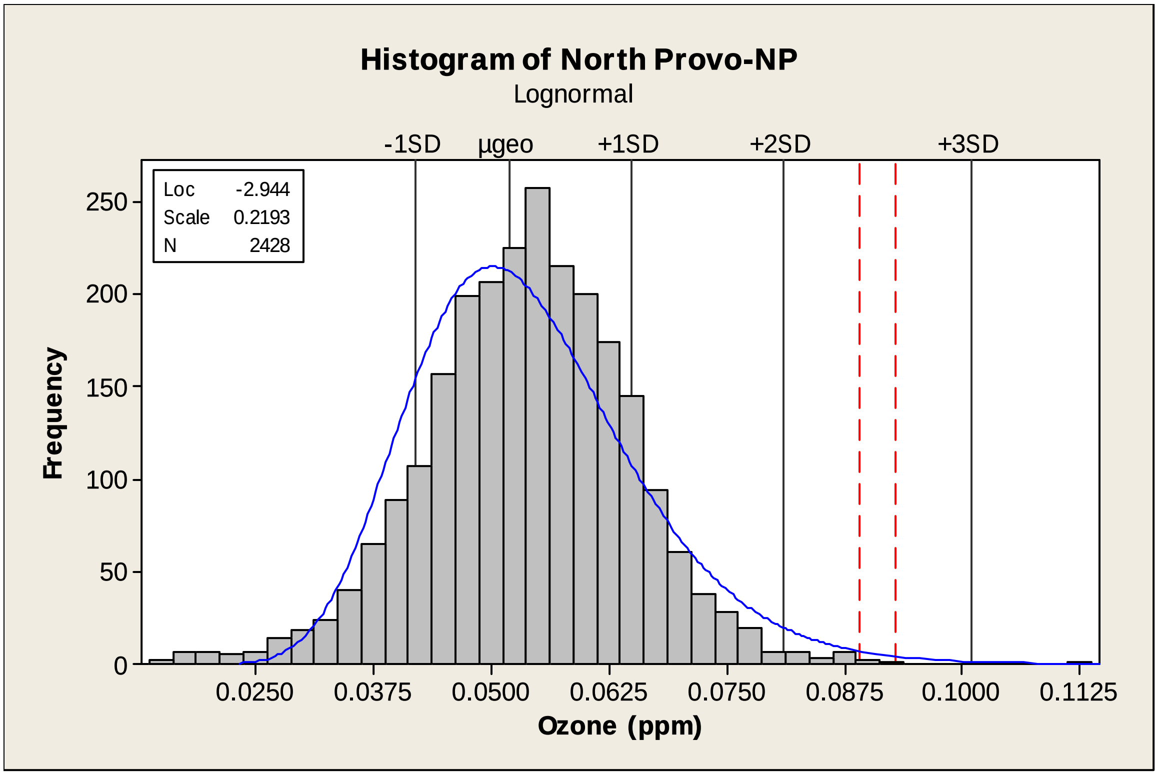

Figure 52. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 1995-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.089 ppm and 0.093ppm.
- The difference between the measured concentration and the Geometric Mean is 0.037 ppm and 0.041 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the North Provo monitoring site would then be 0.065 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.024 ppm and 0.028 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Saltair, 49-035-3005, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 27. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 28. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.

  – Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 28. Best Subset Regression Analysis for the North Provo Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Change	Average Windspeed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	34.5	34.4	229.8	0.010546												X				
1	31.9	31.9	270.6	0.010747													X			
2	43.9	43.7	79.6	0.0097663	X											X				
2	43.0	42.9	93.4	0.0098402	X												X			
3	45.2	45.0	60.5	0.0096581	X		X									X				
3	45.1	44.9	61.7	0.0096647	X							X				X				
4	47.7	47.5	21.1	0.0094359	X		X					X				X				
4	46.8	46.5	36.2	0.0095197	X		X						X			X				
5	47.9	47.6	19.6	0.0094221	X		X					X				X				X
5	47.8	47.5	21.2	0.0094306	X		X	X				X				X				
6	48.9	48.5	6.6	0.0093434	X		X					X				X			X	X
6	48.4	48.0	14.1	0.0093856	X		X					X				X		X		X
7	49.1	48.6	5.6	0.0093319	X		X					X				X		X	X	X
7	49.0	48.6	6.2	0.0093354	X		X					X				X	X		X	X
8	49.2	48.7	5.6	0.0093262	X		X					X				X	X	X	X	X
8	49.1	48.6	6.7	0.0093325	X		X		X			X				X		X	X	X
9	49.3	48.7	6.2	0.0093242	X		X	X				X				X	X	X	X	X
9	49.2	48.7	6.7	0.0093269	X		X					X		X		X	X	X	X	X
10	49.3	48.7	7.3	0.0093243	X		X	X				X		X		X	X	X	X	X
10	49.3	48.7	7.5	0.0093255	X		X	X	X			X				X	X	X	X	X
11	49.4	48.7	8.4	0.0093250	X		X	X	X			X		X		X	X	X	X	X
11	49.4	48.7	8.7	0.0093266	X	X	X	X	X			X				X	X	X	X	X
12	49.4	48.7	9.6	0.0093263	X	X	X	X	X			X		X		X	X	X	X	X
12	49.4	48.7	9.9	0.0093276	X		X	X		X	X	X		X		X	X	X	X	X
13	49.4	48.6	11.3	0.0093299	X	X	X	X	X		X	X		X		X	X	X	X	X
13	49.4	48.6	11.3	0.0093302	X	X	X	X		X	X	X		X		X	X	X	X	X
14	49.5	48.6	13.1	0.0093347	X	X	X	X	X		X	X	X	X		X	X	X	X	X
14	49.5	48.6	13.2	0.0093351	X	X	X	X		X	X	X	X	X		X	X	X	X	X
15	49.5	48.5	15.0	0.0093398	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
15	49.5	48.5	15.1	0.0093403	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
16	49.5	48.5	17.0	0.0093455	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created:
  - Predicted = 0.247 + (0.00357 * Avg Temp) - (0.000522 * Max Temp) – (0.00193 * Avg Aft. Temp) + (0.000538 * Temp Change) +(0.000051 * Avg RH) - (0.000025 * RH Change) - (0.00103 * Average Windspeed) - (0.000056 * Max Wind Speed) - (0.000028 * Max Wind St Dev Hz) +(0.000066 * Average Solar) +

(0.000014 * Average Aft. Solar) + (0.000277 * AvgBP) – (0.000626 * 'MaxBP') + (0.000597 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 2428 observations from, 1993-2008, only 820 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

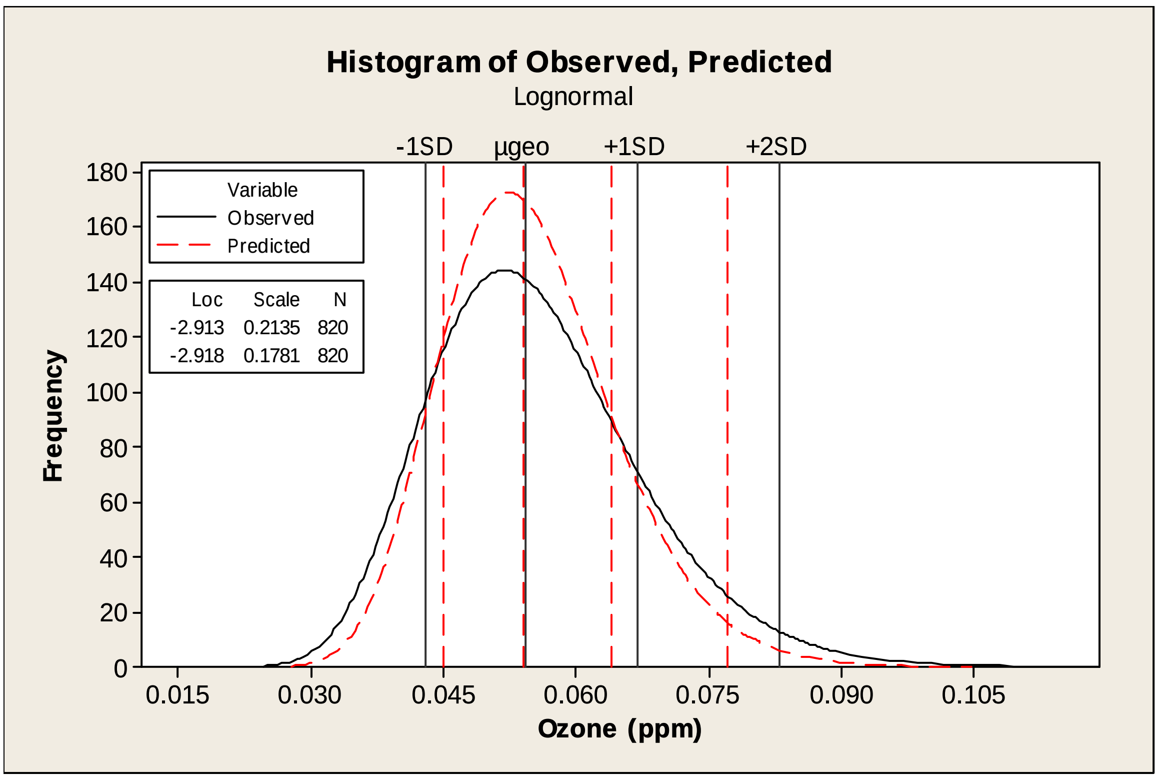

Figure 53. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 53 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 29. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	820	0	0.055474	0.000378	0.010829	0.015875	0.048429
Predicted	820	0	0.054850	0.000314	0.008999	0.027968	0.049242

```
Diff        820   0  -0.000624  0.000266  0.007627  -0.045859  -0.005107

Variable      Median        Q3   Maximum
Observed    0.055625  0.062500  0.112625
Predicted   0.056240  0.061815  0.070937
Diff       -0.000166  0.004314  0.035003
```

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.015 ppm if the observed.
  - During the event Ozone was under predicted by 0.024 ppm on July 8, 2008 and 0.025 ppm on July 9, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

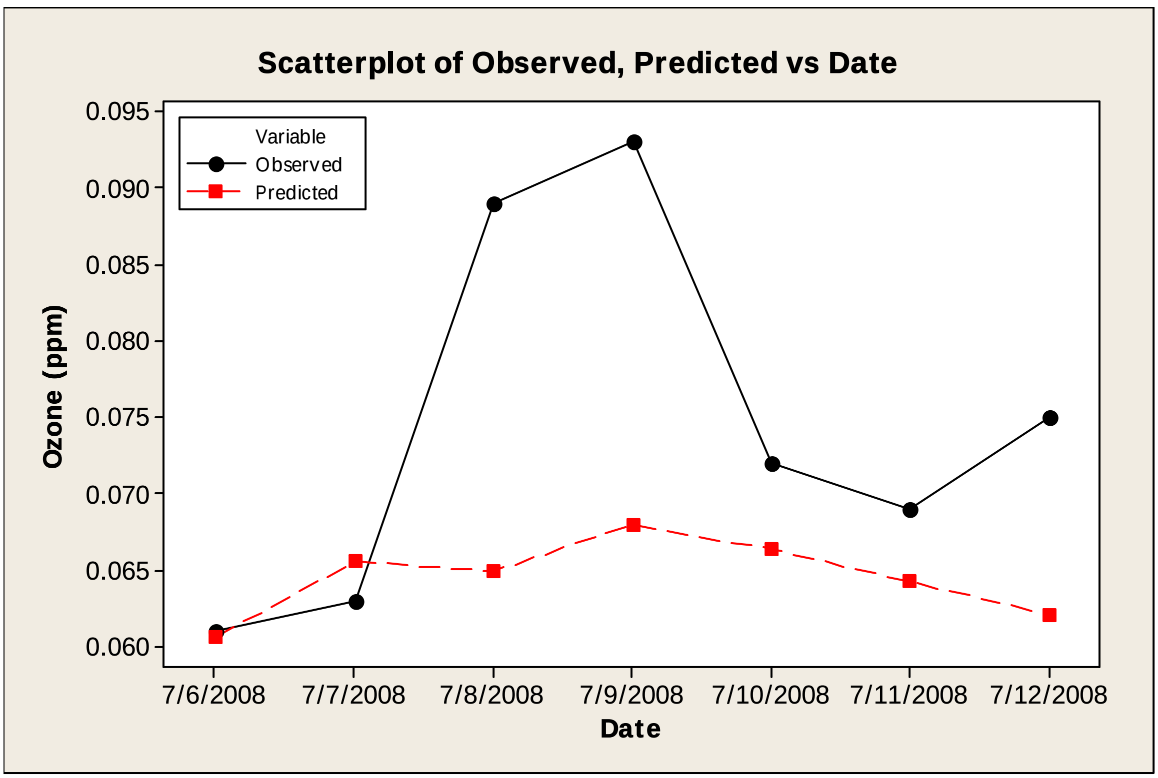

Figure 54. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.024 ppm, for July 8, 2008 and 0.025 ppm, for July 9, 2008 to the event. If not for the event the Ozone concentration at the North Provo monitor would have remained below the NAAQS.

Spanish Fork - SF - 49-049-5010

Historical Normal Fluctuations

- For the analysis of normal historical fluctuations lognormal distributions were used, because of it's ability to accurately describe the data distribution of measured concentration of ozone. Lognormal distributions are described using Location (Loc) and Scale.
  - 11-years of historical data from the Spanish Fork monitor were used for the analysis.
  - All data points from June 1 through August 31 for the years 1998 through 2008 were included.

- Data from the Spanish Fork monitor since 1998 shows that ozone concentration of these dates were above the 95 %ile.
  - Guidance found at 72 FR 55 March 22, 2007 page 13560-81, says that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.)
    - When all data points were aligned in descending order July 8, 2008 lands in the 99.7 %ile and July 9, 2008 in the 99.4 %ile.

- The following are the calculations for the Geometric Mean, Geometric Standard Deviation, and the upper boundary of the 1st, 2nd, and 3rd standard deviations from the Geometric Mean.
  - Geometric Mean (μgeo): Exp(Loc)=0.056
  - Geometric Standard Deviation (σgeo): Exp(Scale)= 1.214
  - +1 Standard Deviation (+1SD): Exp(Loc +Scale)= μgeo* σgeo= 0.068
  - +2 Standard Deviation (+2SD): Exp(Loc +2*Scale)= μgeo* (σgeo)^2= 0.083
  - +3 Standard Deviation (+3SD): Exp(Loc +3*Scale)= μgeo* (σgeo)^3= 0.101

- Figure 55 is a histogram of the historical ozone values. The event values are marked with red dashed lines. The blue line is a fitted line overlay of a lognormal distribution.

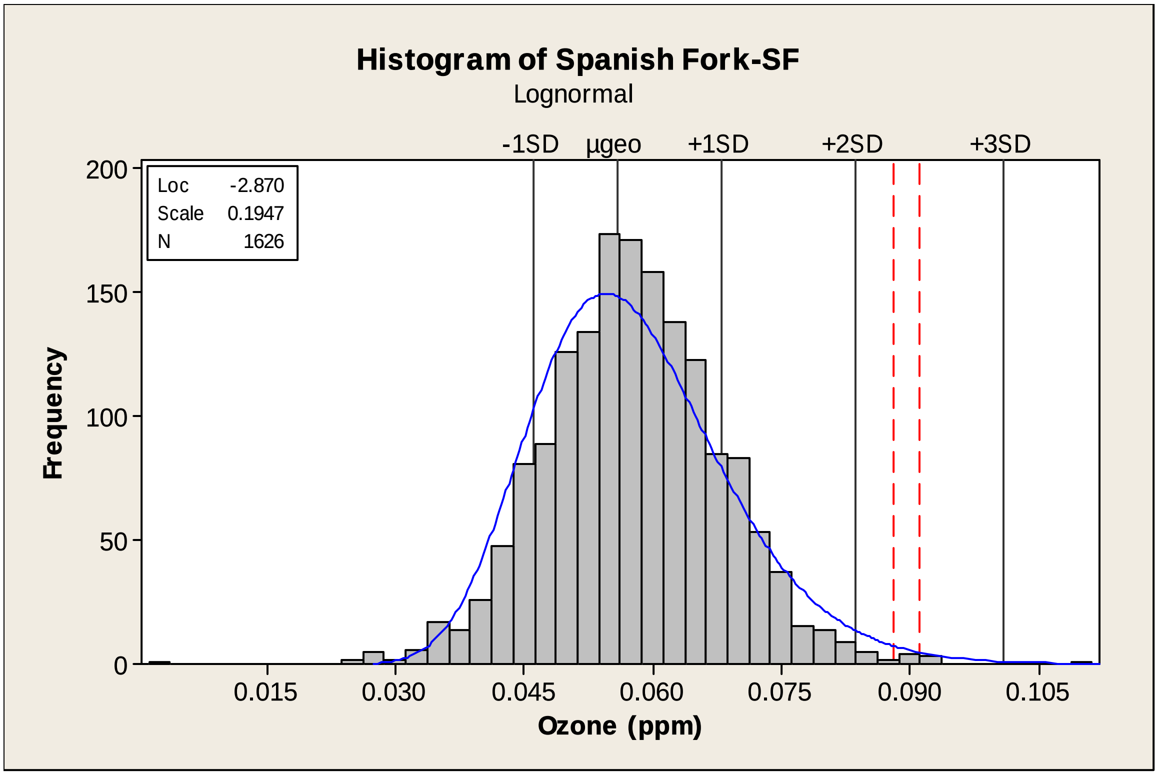

Figure 55. Histogram of observed 24hr. Max 8hr. Average Ozone Values during the Ozone seasons from 1998-2008, July 8th and 9th 2008 values marked in Red Dashed lines.

- The measured concentrations associated with the event were 0.091 ppm and 0.088ppm.
- The difference between the measured concentration and the Geometric Mean is 0.035 ppm and 0.032 ppm.
- Normal historical fluctuation might be described as one standard deviation above or below the Geometric Mean; this is equivalent to a 68% Prediction Interval.
  - The upper boundary of this fluctuation for the Spanish Fork monitoring site would then be 0.068 ppm.
  - The difference between the measured concentration and the upper boundary of the normal historical fluctuation is 0.023 ppm and 0.020 ppm.

"But for" the Event/Regression analysis:

- A regression analysis is often used to calculate the expected ozone value during an event. For this analysis weather variables available through the EPA AQS system and Utah's monitoring network were used. Due to issues compiling a complete data set weather data had to be compiled from two different monitors. Temperature, Relative Humidity, Wind Speed, Wind Direction, Changes in Horizontal Wind Direction, and Solar Radiation were gathered from Saltair, 49-035-3005, and Barometric Pressure from Hawthorne, 49-035-3006, from 2002-2008 during the ozone season. The year 2002 was chosen as a cut point due to availability of data.

- The stated variables were gathered as hourly values. This does not allow for easy comparison to the 24hr. Max 8hr. Average Ozone value, so new variables were calculated from the data.

Table 30. Table of variables considered for regression analysis and their description.

Variable Calculation	Description
Avg Temp	24hr Average Temperature
Max Temp	24hr Maximum Temperature
Min Temp	24hr Minimum Temperature
Avg Aft. Temp	Average Temperature from 12:00 pm to 6:00pm
Temp Change	MaxTemp-Min Temp
Avg RH	24 hr average Relative Humidity
Max RH	24hr Maximum Hr Relative Humidity
Min RH	24hr Minimum Relative Humidity
RH Change	Max RH-Min RH
Average Windspeed	24hr Average Wind Speed
Max Wind Speed	24 Hr Maximum Wind Speed
Max Wind St Dev Hz	Max Standard Deviation of the Horizontal Wind Direction
Average Wind St Dev Hz	Average Standard Deviation of the Horizontal Wind Direction
Average Solar	24hr Average Solar Radiation
Max Solar	24hr Maximum Solar Radiation
Average Aft. Solar	Average Solar Radiation from 12:00 pm to 6:00pm
MaxBP	24hr Maximum Barometric Pressure
MinBP	24hr Minimum Barometric Pressure
AvgBP	24hr Average Barometric Pressure
DiffBP	MaxBP-MinBP

- From these variables a best subset analysis was run. This analysis calculates the R squared (R-sq) value for each combination of variables.

- Table 31. is the output file resultant form a Best Subset Regression analysis. This shows the analysis of the available weather variables and their correlation to the observed Ozone. The Larger the R-squared (R-sq) the better the correlation.

- From the Best Subset Regression analysis the variables used in the regression analysis were chosen. The highlighted row represents the chosen set of variables.
  - Some of the variables were found to be highly correlated and thus not all variables originally created were used in the analysis.

Table 31. Best Subset Regression Analysis for the Spanish Fork Monitor.

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	Avg Temp	Max Temp	Avg Aft. Temp	Temp Change	Avg RH	Max RH	RH Changed	Average Wind speed	Max Wind Speed	Max Wind St Dev Hz	Average Wind St Dev Hz	Average Solar	Average Aft. Solar	Avg BP	Max BP	Diff BP
1	35.8	35.7	243.0	0.0081606												X				
1	33.5	33.4	282.3	0.0083088													X			
2	43.6	43.5	114.5	0.0076528	X											X				
2	43.0	42.8	125.5	0.0076975		X										X				
3	47.6	47.4	50.7	0.0073851	X							X				X				
3	46.4	46.2	69.7	0.0074648	X							X					X			
4	48.8	48.6	31.9	0.0073016	X		X					X				X				
4	48.4	48.2	37.9	0.0073270	X							X				X				X
5	49.7	49.4	19.3	0.0072432	X		X					X				X				X
5	49.2	48.9	27.9	0.0072804	X				X			X				X				X
6	50.3	50.0	10.7	0.0072019	X		X					X				X			X	X
6	50.1	49.7	14.3	0.0072174	X		X					X				X		X		X
7	50.5	50.1	9.0	0.0071900	X		X		X			X				X			X	X
7	50.4	50.0	10.8	0.0071980	X		X			X		X				X			X	X
8	50.7	50.2	8.5	0.0071839	X		X	X	X			X				X			X	X
8	50.6	50.2	9.1	0.0071863	X		X		X			X			X	X			X	X
9	50.8	50.3	8.5	0.0071794	X		X	X	X			X				X	X		X	X
9	50.8	50.3	8.5	0.0071795	X		X	X	X			X			X	X			X	X
10	50.9	50.3	8.3	0.0071742	X		X	X	X			X			X	X	X		X	X
10	50.9	50.3	8.9	0.0071765	X	X	X	X	X			X				X	X		X	X
11	51.0	50.4	8.9	0.0071723	X	X	X	X	X	X		X				X	X		X	X
11	51.0	50.4	8.9	0.0071723	X	X	X	X	X			X			X	X	X		X	X
12	51.1	50.4	9.5	0.0071704	X	X	X	X	X	X		X			X	X	X		X	X
12	51.1	50.4	9.9	0.0071724	X	X	X	X	X		X	X			X	X	X		X	X
13	51.1	50.3	11.2	0.0071734	X	X	X	X	X	X		X			X	X	X	X	X	X
13	51.1	50.3	11.4	0.0071743	X	X	X	X	X	X		X	X		X	X	X		X	X
14	51.1	50.3	13.1	0.0071773	X	X	X	X	X	X		X	X		X	X	X	X	X	X
14	51.1	50.3	13.1	0.0071776	X	X	X	X	X	X	X	X			X	X	X	X	X	X
15	51.1	50.2	15.0	0.0071815	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
15	51.1	50.2	15.0	0.0071817	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
16	51.1	50.2	17.0	0.0071858	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

- From the selected variables a regression equation was created: Predicted = 0.162 + (0.00262 * Avg Temp) - (0.000576 * Max Temp) - (0.00122 * Avg Aft. Temp) + (0.000626 * Temp Change) + (0.000074 * Avg RH) - (0.000031 * RH Change) - (0.00112 * Average Windspeed) - (0.000110 * Average Wind St Dev Hz) + (0.000050 * Average Solar) +(0.000009 * Average Aft. Solar) - (0.000201 * MaxBP) + (0.000297 * DiffBP)

- This equation was applied to the historical meteorological data to calculate a predicted ozone value based on weather. The difference from the actual observed value and the Predicted value was also calculated. Below is the Descriptive Statistics for the observed, predicted, and difference.

- Of the original 1626 observations from, 1998-2008, only 834 days contained all weather variables needed to conduct the regression analysis. To allow for better comparison, dates that do not contain a complete weather data set were not used for the remainder of the analysis.

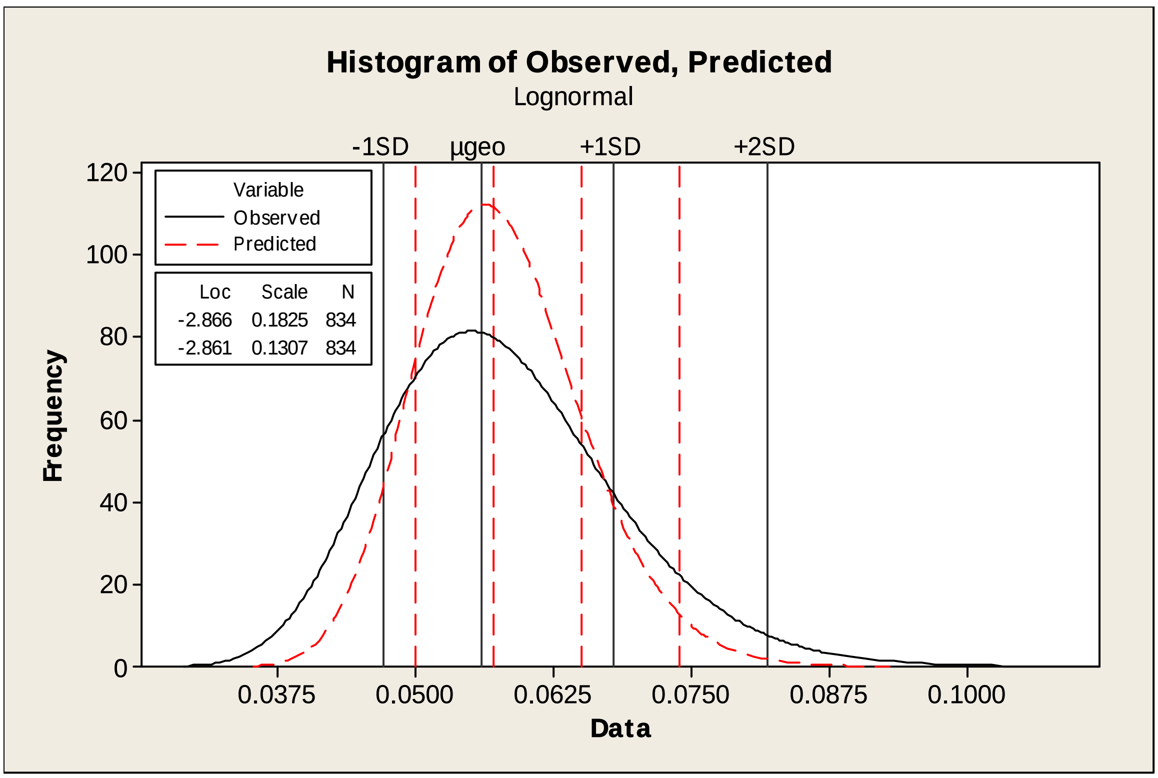

Figure 56. Histogram Fitted Line plot of Observed Ozone and Predicted Ozone.

- Figure 56 shows an overlay of the fit lines for both the observed and the predicted Ozone values, along with lines indicating their geographic mean (µgeo), one standard deviation above the mean, two standard deviations above the mean, and one standard deviation below the mean (-1SD). The reason for the differences in the predicted and the observed are due to the inability to accurately predict anomalies. They accrue more frequently the further away from the mean you move and in turn cause the predicted ozone to not have the same spread in the data as observed.

Table 32. Descriptive Statistics of Observed, Predicted, and the Difference

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1
Observed	834	0	0.057865	0.000353	0.010180	0.026750	0.050844
Predicted	834	0	0.057706	0.000249	0.007194	0.035817	0.053018
Diff	834	0	-0.000158	0.000247	0.007121	-0.042475	-0.004662

Variable	Median	Q3	Maximum
Observed	0.057750	0.064500	0.110000
Predicted	0.058490	0.063241	0.072133
Diff	0.000053	0.004675	0.026641

- Both the mean and the median of the difference between the predicted and the original are near zero. 95% of the time the predicted is within 0.014 ppm if the observed.
  - During the event Ozone was under predicted by 0.026 ppm on July 8, 2008 and 0.017 ppm on July 9, 2008.

- The following graph shows actual observed ozone, in black, and the predicted ozone, in dashed red, from July 6, 2008, to July 12, 2008. For times leading up to the event and after the event the predicted and the observed were similar to each other. During the event the predicted remained consistent and the observed rose dramatically. The predicted during the time shown remain below the NAAQS for Ozone, 0.075 ppm.

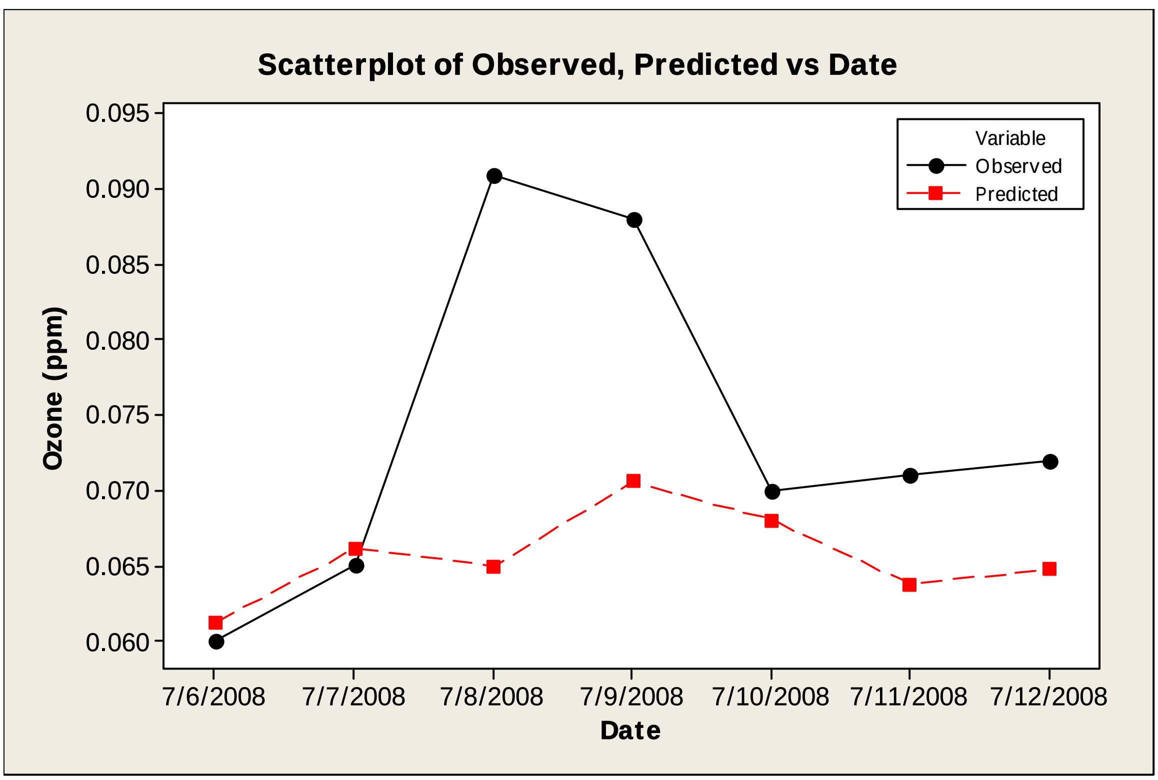

Figure 57. Scatter plot of Observed and Predicted from July 6 – 12, 2008.

- Using the regression analysis we can attribute 0.026 ppm, for July 8, 2008 and 0.017 ppm, for July 9, 2008 to the event. If not for the event the Ozone concentration at the Spanish Fork monitor would have remained below the NAAQS.

Mitigation of Event

- State Action included:
  - A Smoke management rule, R307-204 and Smoke management plan helped minimize smoke from other sources during the event.
    - The rule and plan state that new prescribed fires and new wildland fire use events would not be approved if there was a potential to exceed the NAAQS.
  - News releases during the episode that advised citizens of the potential health impacts of smoke from wildfires. (see Attachment C)
    - Staff also participated in interviews with news media.
  - Email notices from electronic Mail Service sponsored by the Utah Department of Environmental Quality were utilized to notify media contacts. (see Attachment D)
  - A series of pages that can be seen in Figure 58 to Figure 61 about emissions from wildfire were posted on the web during the event.

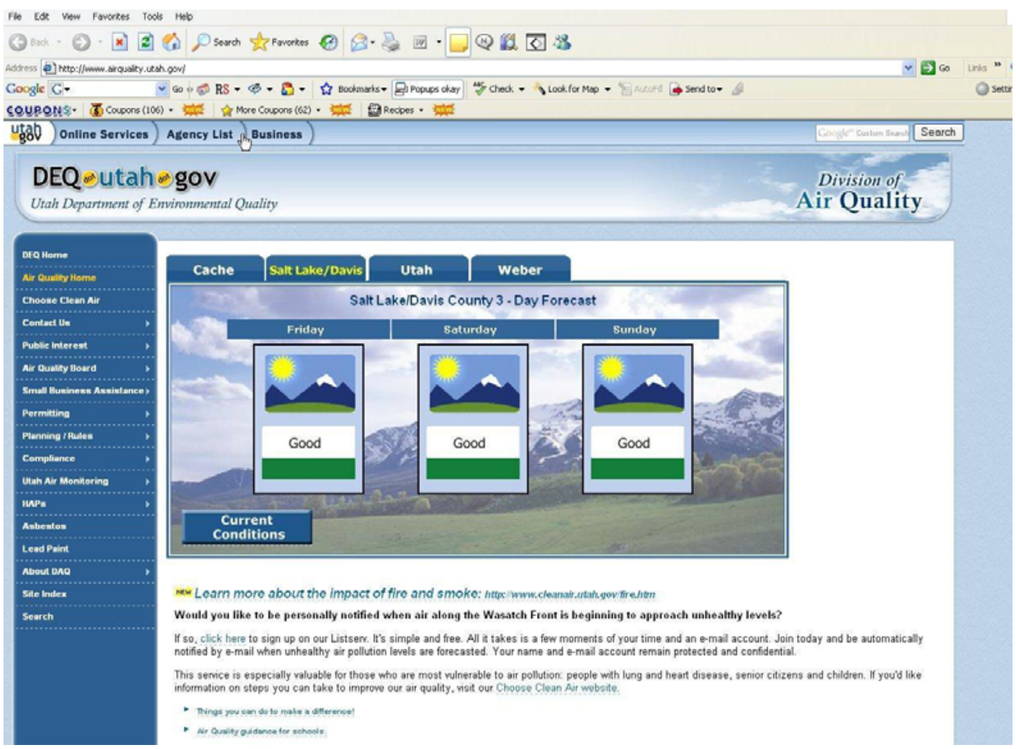

Figure 58. Screen Save from Utah Division of Air Quality, website, http://www.airquality.utah.gov/

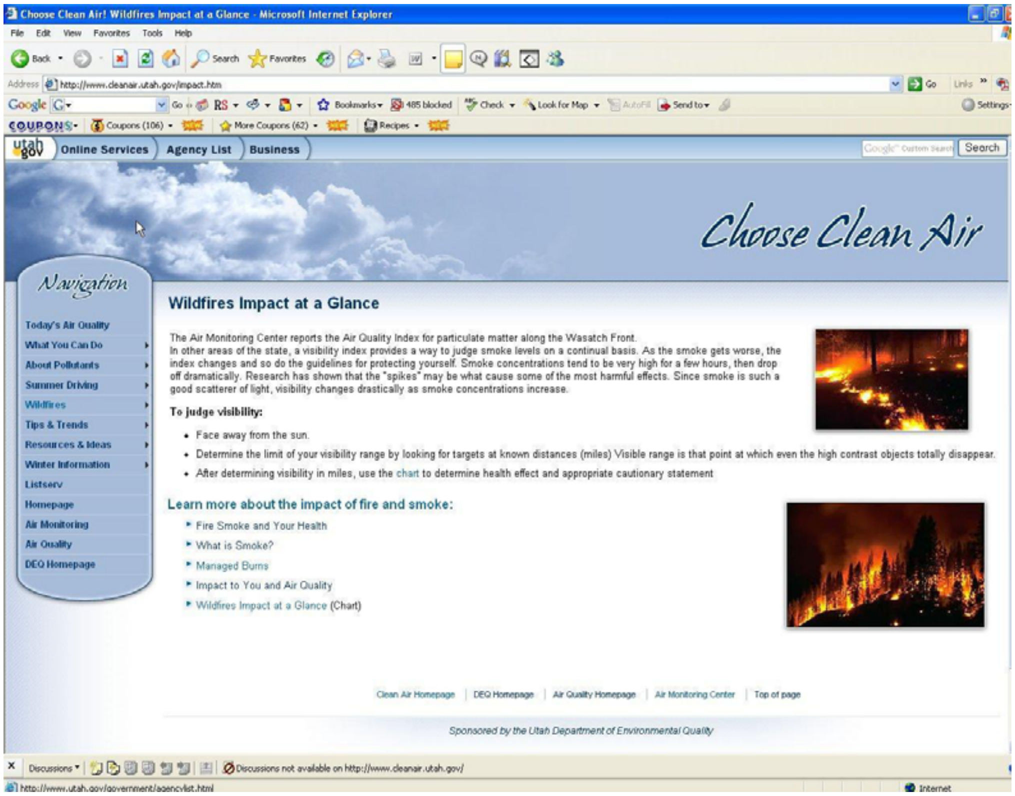

Figure 59. Screen Save from Utah Division of Air Quality, website, http://www.airquality.utah.gov/

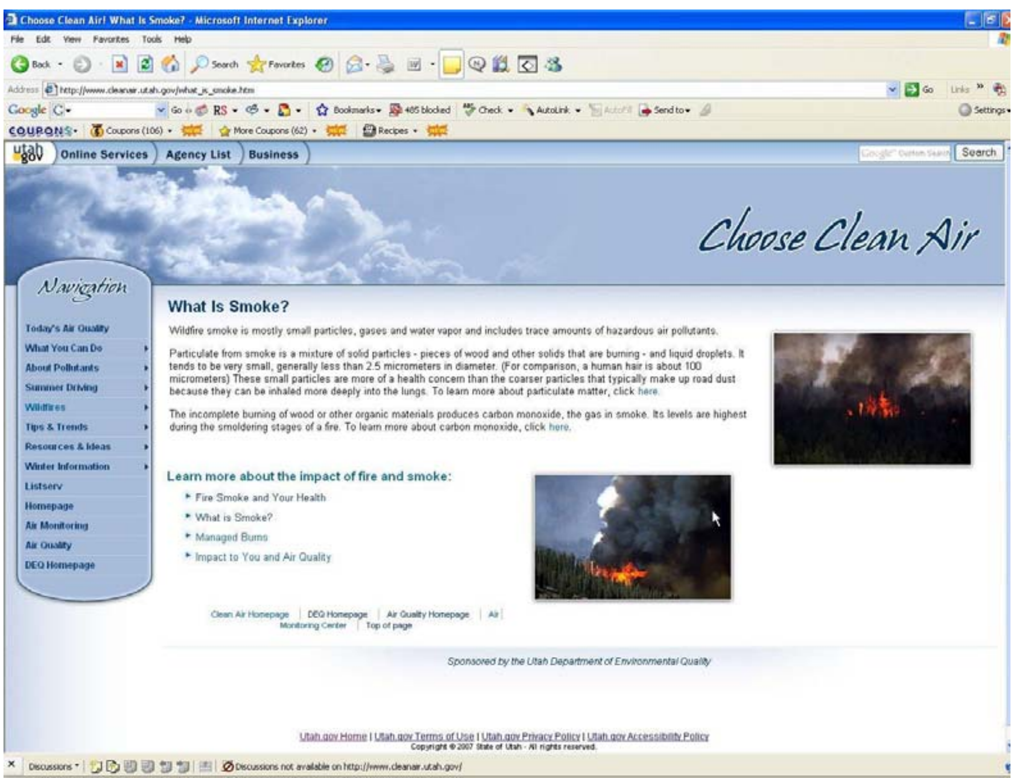

Figure 60. Screen Save from Utah Division of Air Quality, website, http://www.airquality.utah.gov/

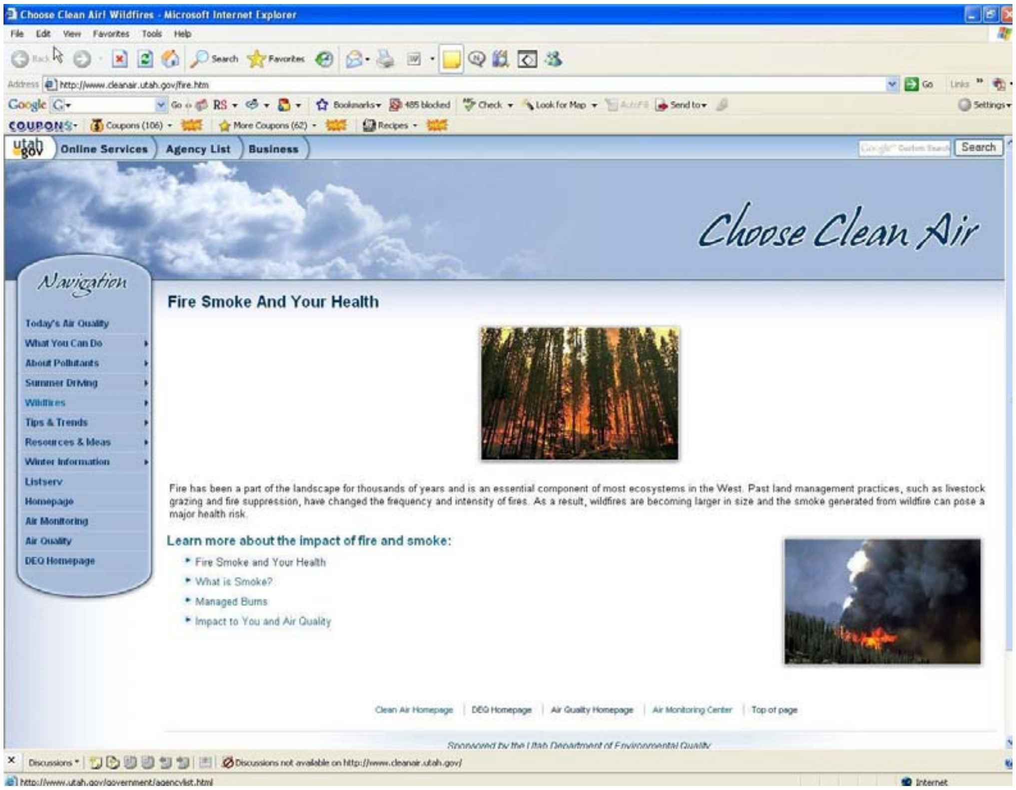

Figure 61. Screen Save from Utah Division of Air Quality, website, http://www.airquality.utah.gov/

Public Review and Comment

- UDAQ established a comment period from January 15, 2009 through February 17, 2009.
  - The announcement of the comment period was published in the Salt Lake Tribune and Deseret News on January 14, 2009. See the Affidavit of Publication below.
  - **Place a copy of receipt from newspaper here.**
- To aid in the public review and comment period, a website was developed to post the justification documentation for this event.

Place the new Website screen save here in the final record of the documentation.

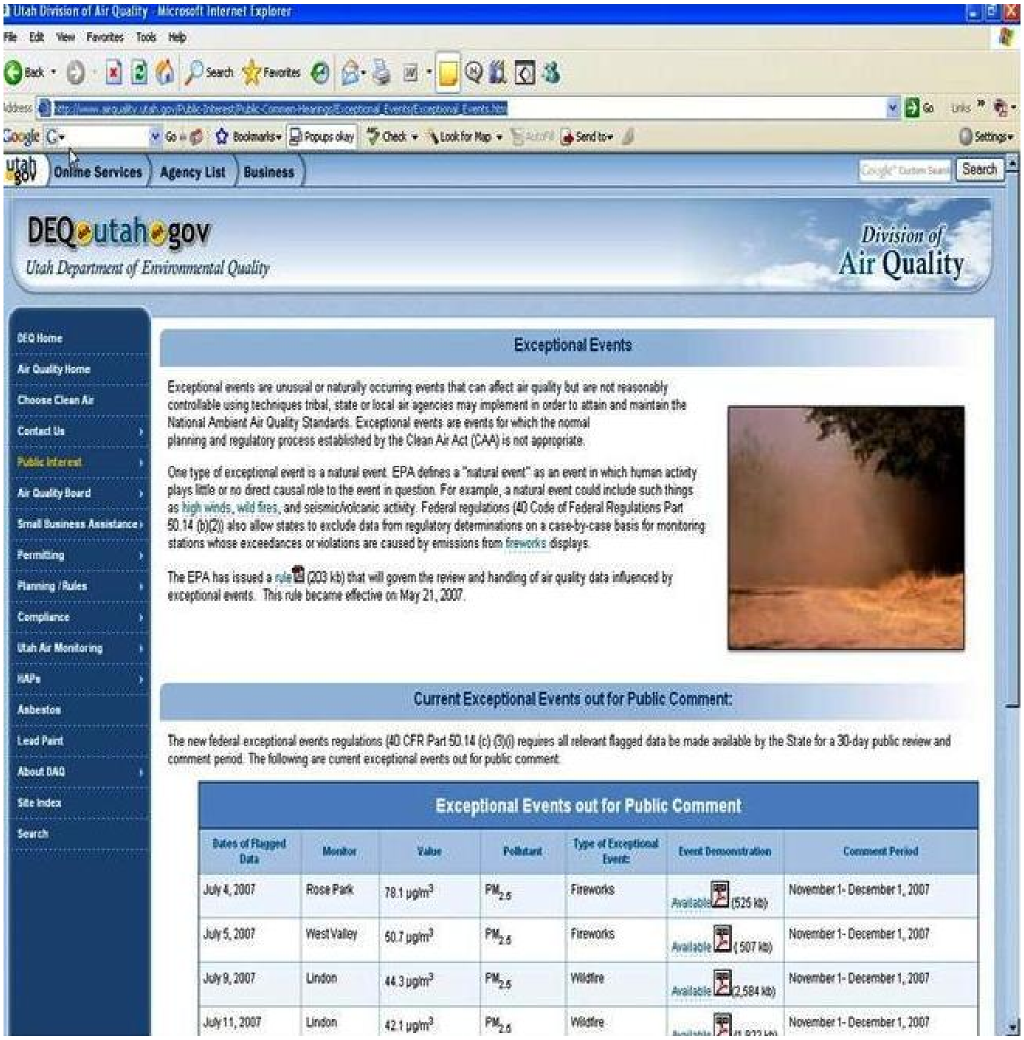

Figure 62. Screen Save from Utah Division of Air Quality, website, from previous exceptiona events http://www.airquality.utah.gov/

List of Attachments

Attachment A	News article from Environmental Science and Technology Journal
Attachment B	Article from “US Air Quality Smoke Blog”
Attachment C	Copies of the UDAQ news releases
Attachment D	Email notice